WORKSHOP

Workshop on the Leon County Mosquito Control Program and Adulticiding Alternatives

Leon County Board of County Commissioner Chambers
Leon County Courthouse, 5th Floor

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Board of County Commissioners
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Workshop Item

February 9, 2010

Title: Workshop on the Leon County Mosquito Control Program and Adulticiding Alternatives

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Background:

At the November 10, 2009 regular meeting, the Board received information regarding the County's current "Mosquito Control No-Spray Program" (Attachment #1). The agenda item was prepared and presented for Board direction due to recent conflicts within the Orchard Walk Subdivision concerning a planned fog-truck spraying.

Similar conflicts had arisen in the past in a variety of neighborhoods, but had been resolved by staff in a manner acceptable to all parties. Resolution of the conflicts included the development of the current, informal, no-spray program which has been in effect for more than 15 years. The recent conflict, however, raised the question as to whether an informal process responding to "no-spray" requests was still a sufficient practice for the County.

After hearing from staff and several citizens on November 10, the Board requested the issue be taken to the Science Advisory Committee (SAC) for its input and opinions and that a workshop be scheduled for February 9, 2010, to address the issue in more detail.

As directed, Public Works staff provided the information to SAC and made a presentation at its meeting on January 8, 2010 (Attachment #2). The Committee asked for time to review the information and for staff to attend its February 5 meeting with more information on the items that would be addressed during the workshop.

Subsequently, staff has prepared the following workshop material for Board discussion and consideration. The packet is broken into five sections and covers the following information:

- State Statutes and Program Oversight
- Explanation of an Integrated Pest Management System and how it is implemented in Leon County (including treatment techniques)
- Comparisons to other programs
- Alternative Control Strategies
- Summary and Potential Program Modifications

Analysis:

State Statutes and Program Oversight:

Mosquito Control programs are not mandated by the State, but legal authority is provided for local governments to conduct mosquito control as a government activity. Almost all counties have established mosquito control programs for disease prevention and to improve the quality of life.

When counties choose to provide the service, the activities operate under the requirements of Chapter 388, F. S. and Florida Administrative Code, Rule 5E-13. In part, Chapter 388 states:

> **388.101 Declaration of legislative intent.**--It is declared to be the public policy of this state to achieve and maintain such levels of arthropod control as will protect human health and safety and foster the quality of life of the people, promote the economic development of the state, and facilitate the enjoyment of its natural attractions by reducing the number of pestiferous and disease-carrying arthropods. It is further declared to be the policy of the state to conduct arthropod control in a manner consistent with protection of the environmental and ecological integrity of all lands and waters throughout the state.
>
> **388.161 District boards of commissioners; powers and duties.**-- (1) The board of commissioners may do any and all things necessary for the control and elimination of all species of mosquitoes and other arthropods of public health importance and the board of commissioners is specifically authorized to provide for the construction and maintenance of canals, ditches, drains, dikes, fills, and other necessary works and to install and maintain pumps, excavators, and other machinery and equipment, to use oil, larvicide paris green, or any other chemicals approved by the department but only in such quantities as may be necessary to control mosquito breeding and not be detrimental to fish life.
>
> **388.241 Board of county commissioners vested with powers and duties of board of commissioners in certain counties.**--In those counties where there has been no formation of a separate or special board of commissioners, all the rights, powers, and duties of a board of commissioners as conferred in this chapter shall be vested in the board of county commissioners of said county.

The State agency responsible for carrying out and monitoring Chapter 388 is the Department of Agriculture and Consumer Services (DACS), more specifically, the Bureau of Entomology and Pest Control's Mosquito Control Section. In a review of the lists maintained by DACS and Special Districts Online, 62 mosquito control programs within Florida were identified (Attachment #3). Of those, 31 programs are governed by a Board of County Commissioners; 15 are Independent Special Districts; 10 are Dependent Special Districts; 2 are run by the County Health Department; and 4 did not identify the type of agency they are.

In addition to programs established by local governments, licensed pest control companies provide mosquito control for private landowners, homeowners associations, resorts, etc. All of these activities are, however, still required to operate under the requirements of state law and rules.

Integrated Pest Management System:

The Leon County Mosquito Control Program (Program), has been in existence since the late 1950's. Prior to the mid 1990's, the program was under the direction of the Leon County Health Department and its primary responsibility was maintaining the large mosquito control ditches which are found throughout the city and county. Since then, the Program, governed by the Board of County Commissioners and funded through general revenue, resides within the Department of Public Works. The transition allowed for the Program to acquire staffing such that source reduction and control programs, such as larviciding, adulticiding, and citizen education, could be expanded.

The Program, within the Division of Operations, employs Integrated Pest Management (IPM) strategies to control mosquitoes in Leon County; and it accomplishes this with a current budget of $563,000 (Table #1). IPM strategies, in general, utilize source reduction techniques; monitoring to determine if and when treatments are needed; physical, mechanical, cultural, biological, and chemical treatments; and community education in an effort to reduce mosquito populations and mosquito-borne illnesses.

Table 1: Budget Summary

Program	Amount	% of Total
Source Reduction		
Mosquitofish Program	$ 9,673	1.7
Waste Tire Program	$ 10,763	1.9
Surveillance Techniques*		
Sentinel Chicken	$ 15,530	2.8
Community Education Program	$ 14,983	2.7
Larviciding Program	$ 229,703	40.8
Adulticiding Program		
Hand-Fogging Program	$ 76,193	13.5
ULV Truck Spraying Program	$ 206,331	36.6
Total	$ 563,177	

* Other surveillance techniques are not broken out specifically and absorbed in the overall budget.

Source Reduction

In Leon County, the first lines of defense for the mosquito control program are to use environmentally-sound source reduction techniques to disrupt the mosquito's life cycle. The two primary techniques used are stocking mosquitofish in abandoned swimming pools, backyard ornamental ponds, etc. and the waste tire program.

Mosquito fish are small, freshwater minnow-like fish native to the Southeastern U.S. They are surface feeders and eat mosquito eggs and larvae. The fish are hardy, capable of surviving in stagnant water, grow only to about two inches in length and breed to the size of their container to prevent overcrowding. Mosquito Control staff place fish on a "request basis" from citizens. Due to funding and staffing limitations, this service is not highly publicized, but it is noted on the County's webpage and the educational brochure.

Prior to any placement, an evaluation of the facility where the fish will reside is conducted to ensure proper usage. Because mosquitofish also feed on the eggs and young of other insects and fish, caution is given to stocking them in facilities/water bodies that connect to lakes, streams or rivers. The high stocking rate of one thousand fish per acre required for adequate control of mosquito populations could negatively impact downstream habitats if proper precautions are not take to prevent the inadvertent release of mosquito fish from the treatment area.

With regard to waste tires, calls from citizens requesting the removal of used tires along roads and in vacant lots prompted an investigation by staff. Staff discovered that due to the problems associated with the removal and disposal of discarded tires, haulers did not pick up tires in neighborhoods. Consequently, the waste tire program was created in 2001 to address this problem. The waste tire program is available to all residents and up to four tires will be removed from a residential property by mosquito control staff. This activity occurs predominately during the winter months when larviciding and adulticiding activities are suspended. The current program collects approximately 2,000 used tires per year which are then transported to the solid waste facility for recycling, at which time a tipping fee is applied and paid for out of the mosquito control budget. Due to funding and staffing limitations, however, staff has been cautious in conducting a large-scale media promotion of the program.

Other programs, such as Stormwater Maintenance and Growth and Environmental Management also conduct source reduction techniques as part of their day-to-day operations. For example, the stormwater maintenance of roadside ditches to improve drainage and eliminate standing water is a valuable activity which reduces the potential of flooding and eliminates mosquito breeding habitats. Also, the engineering design standard which is found in the County's Environmental Management Act and requires that dry detention and retention stormwater ponds draw down within a 72 hour period was created to prevent the creation of mosquito habitats. These activities and policies at their core are performing mosquito control functions even though they are not funded under the mosquito control program.

Source reduction, to be most effective, needs to not only occur through County-sponsored activities, but also be applied at an individual level. To teach citizens source reduction techniques as well as other valuable information regarding mosquito control, the Program has a community education component.

Community Education

Community education for mosquito control revolves around two basic tenets: 1. Individual efforts towards source reduction can significantly lower the breeding of mosquitoes around businesses and homes; and 2. Personal protection through the use of protective clothing and

insect repellents significantly decreases the likelihood of being bitten (Attachment #4). The Program utilizes the County's website (Attachment #5); community/school presentations; an informational flier (Attachment #6); public announcements and advertisements during mosquito season; and the award-winning video, *The Mosquito Menace*, produced by staff in 2004, as modes of educational outreach to students, homeowners associations, clubs, etc. Prior to FY10, most of these efforts were coordinated through a part-time, OPS staff person. Due to budget constraints, however, the position was eliminated and the efforts were absorbed by the Mosquito Control Supervisor and the Stormwater Superintendent along with the assistance of Public Information Office.

Source reduction and community education, however, will never reduce mosquito populations to nil. To determine how intrusive the mosquito population is at any given time, which in turn, assists in determining the level of treatment needed, the Program utilizes a variety of monitoring/surveillance techniques.

Monitoring/Surveillance Techniques

The Program utilizes three types of monitoring/surveillance techniques. Those are the Sentinel Chicken program; monitoring the rate of traps and landing counts; and larval sampling. The Sentinel Chicken program is designed specifically to monitor for mosquito-borne illnesses. Those are Eastern Equine Encephalitis (EEE), West Nile Virus (WNV) and St. Louis Encephalitis (SLE). Surveillance flocks consist of six chickens each in three cages. These cages are placed at seven locations throughout the county. Blood samples are taken weekly between the months of May and December. The blood samples are processed and sent to the state laboratory in Tampa for analysis. Results are then returned to staff and used in planning public notification and/or control strategies as needed. Should the severity of the reports indicate an outbreak of one of the aforementioned illnesses, the County Health Department will become involved in issuing public health notices and health warnings.

The data obtained through the use of traps and landing counts is particularly useful in determining the need for truck or aerial spraying. It is also used to determine the effectiveness of control efforts once a spray mission has been completed. Mosquito Control uses CO_2 baited light traps to monitor adult mosquito populations allowing staff to collect data and document increases (or decreases) in populations. Likewise, landing rates are gathered in the field by counting all mosquitoes observed landing on a technician within one minute intervals. These surveillance methodologies allow for the determination of the type of mosquito and the relative abundance of each type of mosquito.

Larval surveillance is the monitoring of specific ground sites and aerial sites that are known as significant mosquito breeding habitats. These sites include a vast array of habitats including but not limited to, roadside ditches, abandoned tire piles, abandoned swimming pools, woodland pools, freshwater wetlands and swamps. Sites have been mapped using GIS and GPS technologies and are routinely monitored for mosquito production.

Treatment Techniques: Larviciding

The first line of treatment, is selective application of environmentally-compatible, EPA-registered larvicides (products designed to kill mosquitoes while they are still in the concentrated aquatic life stage). This consists of a ground and aerial component and products are applied to the areas where mosquitoes breed. Approximately 80% of these larviciding activities occur with the urban service area of the county.

Staff monitors and treats more than 800 ground sites which are known larval habitats. Ground-applied larvicides are used in urban areas to treat roadside ditches, flooded fields, abandoned swimming pools, woodland pools, swales, lawn puddles, etc. The aerial larviciding component utilizes the Sheriff's helicopter to treat freshwater wetlands, flooded woodlands, or swamps, and is done only as warranted based upon intensive field surveys of larval occurrence, distribution and abundance. More than 1,500 acres that are known larval habitats are monitored on a regular basis and treated with the helicopter when necessary.

To be effective, larvicides must be applied during a very restricted period in the mosquito's aquatic phase of development. One impediment to the effectiveness of larvicide applications is unfavorable weather. When unfavorable larviciding conditions occur or larviciding has been limited in its success, as a last resort the Program turns to the use of adulticiding (the term used to describe spraying practices to control adult mosquitoes).

Treatment Techniques: Adulticiding

Adulticiding involves the application of chemical controls by utilizing hand-spraying units and utilizing truck-mounted Ultra-low Volume (ULV) units. Hand-spraying is generally conducted in the urban areas of the County (approximately 80% within the urban service area); on a request basis; on parcels that are relatively small; and during the day-time hours. The limitation of this treatment is that it is only effective on the Asian-Tiger mosquito. The Asian Tiger mosquito differs from the other mosquitoes in that it primarily breeds in containers and is active and biting during the daytime hours. In the early 1990's the Program began an extensive education and inspection program to advise citizens on the best methods to protect themselves from the Asian Tiger mosquito, however, by 1997 it was determined that additional strategies were required. The Program responded to this challenge in 1998 by launching the use of hand-held foggers to control the adult Asian-Tiger mosquitoes.

It was originally projected that staff could expect to conduct around 1,000 hand-fogs per year. Protocols for the program, therefore, were established based upon this assumption. In 1998 the Program conducted 1,024 hand-fogs. By the year 2003, that number had grown to more than 5,000 per year even though the Program's staffing level had remained virtually unchanged. This resulted in the delay or in some cases the complete cessation of other program functions, most notably the ground larviciding. To address this shortfall the Board adopted the fee-for-service for the hand fogging service in 2004 and amended the program in 2005.

ULV spraying, utilizing truck-mounted units, produces an invisible cloud of droplets that are the proper size to impinge on mosquito wings and bodies without the "fog" produced by thermal expansion of the pesticide mixture. Fogging refers to the long abandoned practice of thermal

fogging which produced a visible cloud of ultra-fine droplets. However, for the purpose of this document staff has chosen to utilize the "fogging" term to reduce confusion among the general public who may not be familiar with the ULV term but readily associate the "fogging" term with the adulticiding program.

Truck fogging, which has been in practice for decades in Leon County, is used to control night-time species of mosquitoes and is generally conducted on a "request basis". Additional fogging may be conducted, at the discretion of Program staff, due to the presence of unacceptable mosquito populations, the potential mosquito-borne disease threats in an area, and/or a declared state of emergency. There is almost an even split between where fogging activities occur (55% in USA and 45% occurs outside of the USA)

The decision to spray for mosquitoes in populated areas depends upon two forms of evidence those being physical evidence and/or complaint evidence indicating that mosquito populations are unacceptably high. The first form, physical evidence, is obtained through the surveillance techniques previously discussed. The second form, complaint evidence, comes as a request for spraying from either individuals, civic or homeowners associations, or designated representatives. To the extent practicable the Program will investigate the need for a spray response based on the physical evidence previously described.

To the extent feasible and practical, adulticide spraying is conducted at times which minimize direct human exposure. The fog trucks usually operate Monday through Friday evenings between dusk and up to four hours after dusk. In the event that inclement weather or other circumstances prevent adulticiding at these times, spraying may be conducted during the weekend evening hours.

The fact remains, though, that fogging generates the greatest concern in some residents due to the chemicals utilized and the drift associated with all fogging techniques. Historically, staff has handled each concern on a case by case basis and through informal no-spray procedures which include the categories of: call before spraying; do not spray subdivision (this can only be requested by a homeowners association); do not spray property/area; and 48-hour written notice (utilized by only one no-spray property). For those on the no-spray list, the Leon County Program does not have a set buffer zone, but rather the current practice is to turn off truck fogging units in front of the requestor's property to honor the no-spray request. To assist with that determination each vehicle has a mobile unit that can pinpoint a no-spray property through GPS coordinates. The driver, therefore, is constantly aware of his location on the route and where no-spray zones/properties exist.

All adulticides used in Leon County for the control of pestiferous mosquito species, and the manner in which they are used, are EPA-approved and registered insecticides. As such these insecticides have demonstrated minimal human health or environmental risks and can be sprayed over or within populated areas. The EPA, as well as independent research, has determined that mosquito control insecticides can be used to kill mosquitoes without posing unacceptable risks to human health, wildlife or the environment (Attachment #7). Additionally, the EPA's product-

labeling process reflects the permitted use and safety precautions that pesticide applicators must follow.

Comparisons to Other Programs

In preparation for the workshop, staff researched other counties in Florida and throughout the United States to make comparisons in budgets and services provided and explore alternatives for county-wide adulticiding. Staff employed the use of websites such as the American Mosquito Control Association; conducted e-mail inquiries and communications with other programs and agencies; and utilized data and resources from DACS. Some of the jurisdictions examined include: the Florida counties of Alachua, Escambia, Lake, Manatee, Marion, Osceola, Sarasota and St. Lucie; Oregon Vector Control; Southern Nevada Health District; Grand River Mosquito Control District (Colorado); the Delaware Department of Natural Resources and Environmental Control, Division of Fish & Wildlife, Mosquito Control Section; and Winnipeg, Canada.

Organizational structures for mosquito control programs vary considerably from county to county and state to state. They include independent taxing districts, dependent taxing districts, county departments, situations where there are multiple jurisdictions operating mosquito control programs within the same county, and situations where the activity is centralized at a state level.

In terms of budget, wide variation exists. A comparison of like-sized Florida counties reveals that Leon County is the lowest for dollars spent per county resident for counties with a single, county-wide mosquito control programs (Table 2). As depicted, per capita funding for mosquito control programs range from $2.04 in Leon County to $20.75 in St. Lucie County.

Table 2: Comparison of Mosquito Control Funding for Like-Sized Counties

Jurisdiction	MC Budget	Area Serviced (Sq. Miles)	Type	Population (thousands)	Net Budget per Capita
Leon	$ 563,177	667	BOCC	275	$ 2.04
Osceola[1]	$ 914,865	1,322	BOCC	274	$ 3.33
Escambia	$ 708,502	663	BOCC	313	$ 2.26
Manatee	$ 4,063,075	741	Independent District	318	$ 12.77
Lake	$ 1,021,868	953	BOCC	288	$ 3.54
St. Lucie[2]	$ 5,748,007	572	Dependent District	277	$ 20.75
Alachua[3]	> $600,000[5]	826	Multiple Jurisdictions	252	See Note[5]
Marion[4]	> $ 70,000[5]	1,530	Multiple Jurisdictions	329	See Note[5]

Notes:
1) Osceola County has budgeted $815,000 for contracted services. The remainder is budgeted for mosquito control contract oversight.
2) Saint Lucie County responsibilities include the management of 4,000 acres of coastal mangrove swamps and salt marshes.

3) Alachua County has multiple programs operated by various jurisdictions. For Example, the Alachua County commission has budgeted $216,000 for larviciding, adult trapping and chicken flocks in the unincorporated area. Whereas, the City of Gainesville has allocated $350,000 for mosquito control services within the city limits.
4) Marion County has multiple programs operated by various jurisdictions. For example, the Marion County commission has budgeted $50,000 for contracted ULV truck spraying. Whereas, the City of Ocala has budgeted $20,000 for contracted ULV truck spraying and the Stormwater Division full-time personnel handle the larviciding program.
5) Unable to determine total amount due to multiple jurisdictions operating programs within the county.

Table 3 represents some of the additional jurisdictions examined, and their associated budgets.

Table 3: Additional Jurisdictions and Associated Budgets

Jurisdiction	Budget	Area Serviced (Sq. Miles)	Type
Leon County, FL	$ 563,177	667	BOCC
Grand River Mosquito Control District (CO)	$ 928,000	78	Independent Special District
West Umatilla Vector Control – Oregon	$800,000	515	Independent District
Southern Nevada Health District	$690,000	8,012	Independent District
Jacksonville (Duval County) Mosquito Control	$2,490,953	757	City Commission
Beach Mosquito Control (Bay County)	$1,621,524	59	Independent Special District
Florida Keys Mosquito Control	$14,795,750	200	Independent Special District
Lee County Mosquito Control	$24,758,853	797	Independent Special District
Sarasota County Mos. Control	$2,985,756	572	BOCC

With regard to services performed within those budgetary parameters, staff research has concluded that an overwhelming majority of programs utilize an IPM strategy which includes an adulticiding component. Once that was established, additional research examined which programs have no-spray policies.

A survey of 60, Florida mosquito control jurisdictions was conducted to determine common practices across the state as they pertain to no-sprays for ULV truck spraying programs (Attachment #8). Staff received 30 responses. Of the responses, 84% of the programs have some form of a no-spray policy in place; however, none had formal written policies describing their procedures. Staff, however, was able to locate two out-of-state programs that had parameters for no-spray zones. Those two were Delaware and Winnipeg, Canada.

The policies from these two jurisdictions indicate a 300 foot/100 meter radius-drift is presumed when fogging techniques are utilized (Attachments #9 and #10). The Board may wish to provide direction to staff in this regard, since, as previously mentioned, the Leon County Program does not currently have a set buffer zone.

Since the County's ULV truck spraying practices are predominately based on "request for service," however, establishing a radius, buffer zone would have significant impact on the number of parcels able to receive/request service. Table 4 depicts the approximate number of parcels that would be impacted if a no-spray buffer was implemented at 300 feet, ¼ of a mile, or completely within the urban service area (Attachment #11). This analysis is based on the current list of 124 on the no-spray list and applying the buffer outward from these areas.

Table 4: Impact of No-Spray Buffers

Radius of Buffer	Number of Parcels Impacted
300 feet	2,822
¼ mile	14,006
Entire Urban Service Area (no adulticiding/fogging)	93,849

Aside from no-spray policies, comparisons of other programs also identified that there are two approaches to fogging. The first is the "request for service" approach. This is the approach utilized in Leon County and in counties where funding and staffing are limited. The second approach, which is common in Florida, involves dividing the service area into zones. This approach requires significant funding and involves monitoring adult trappings or landing rates in each and every zone to determine the adult mosquito populations. When the current thresholds established by the state are met or exceeded, then the programs will spray the entire zone. If followed in Leon County, staff anticipates this approach would increase truck spraying by a factor of 3 to 4 times.

Sarasota County Practices

Sarasota County operates under the second approach mentioned - dividing the County into zones and spraying entire zones when mosquito populations reach a certain threshold. Dr. Eric Schreiber with Sarasota Mosquito Management Services is participating in the workshop to provide an overview of their practices (Attachment #12).

Included in Sarasota's overall program is a no-spray registry/list as done in the Leon County Program. Sarasota maintains a no-spray, master list compiled from two sources: the state registry and a locally compiled list of citizens requesting to be placed on the no-spray list. The master list currently contains about 200 individuals. They have no formal written no-spray policy. For individuals who do not want their property sprayed, the program has established buffer zones as large as a 1/4 mile. Individuals who request prior notification are notified 48 to 72 hours prior to spraying activities via a "robo-dialer" system.

Aside from zones and the no-spray list, Sarasota County has also employed a unique approach to reducing, not eliminating, adulticiding in certain areas. Certain areas in the County have been established as Adulticide Reduction Areas (ARA's).

The objective behind the ARA's is to reduce the need for adulticiding in these areas. This is accomplished by intensive inspections and larviciding. However, adulticiding is still performed in these areas as spot treatments for urban and salt marsh mosquitoes when needed. Currently the

ARA's comprise less than 10% of county and are found along the coast in the highly urban and tourist areas.

The ARA concept works in Sarasota County for two reasons. First, Sarasota County has a significantly larger budget than Leon County. As such, the cost associated with the necessary intensive inspections and the labor-intensive larviciding techniques can be absorbed. Second, because Sarasota County operates by spraying entire zones, contrary to a request for service model, the possibility to reduce spraying through other modes of concentrated efforts exists. In Leon County, however, there is essentially nothing to reduce since the model is based primarily on a request for service basis. In other words, Leon County staff is spraying areas because it has been requested, not because it is in a zone rotation.

Areas outside the ARA's use conventional adulticiding methods, and mosquito trapping is conducted at more than 37 locations three times a week. If adult mosquito numbers in traps increase or high landing rates are noted, a zone-spraying is scheduled. During 2009 Sarasota County conducted adulticiding activities over approximately 250,000 acres through a contracted vendor.

Overall, comparisons of other programs did not identify the use of many alternative control strategies, although some do exist. The following is a discussion of the alternative control strategies that are frequently mentioned and/or ones that have been previously researched.

Alternative Control Strategies

Utilizing the results of the survey, it is apparent that only a handful of mosquito control programs in the state have allocated resources to alternative control strategies. Of those, the alternative strategy utilized has been that of mosquitofish rearing and placement. None of these programs researched currently have active biological control programs utilizing dragonflies, predaceous copepods or Toxorhynchites mosquitoes.

However, the following section discusses strategies are frequently suggested and/or that have been researched. The general categories of alternative control strategies are:

- aquatic predators
- winged predators
- mechanical control devices
- chemical control techniques (other than fogging), and
- personal protection

Aquatic Predators

There are three types of aquatic predators that are generally thought to be somewhat effective in controlling mosquito populations. Those are copepods, dragonflies, and predaceous mosquitoes.

Copepods are tiny aquatic crustaceans that are widespread in both fresh and salt water habitats. Some species of this crustacean have been identified as voracious predators of 1st and 2nd instar

mosquito larvae along with other insect larvae. As with chemical larviciding, it is essential that the breeding habitats of the mosquitoes be known for effective mosquito control with copepods. In addition, since not all copepods are effective mosquito control agents, testing of the particular species should be conducted prior to any significant resource allocation to ensure it accomplishes the goal of controlling larvae populations. Use of this alternative could potentially supplement the County's chemical, larviciding program by limiting the number of larvae hatched. However, the introduction of these predators would not impact any adult population that did survive. Effective strategies for large-scale deployment of the copepods would have to be explored in more detail.

Another aquatic predator alternative identified is the introduction of dragonfly and damselfly nymphs, in large quantities, to known breeding habitats. Dragonfly and damselfly nymphs live in the water eating mosquito larvae and any other animals smaller than themselves until they are ready to cast off their skins and emerge as adults. Florida dragonflies and damselflies can spend one month to three years in the nymph stage and can have multiple broods in a single year. Then, during the adult phase which can last weeks or months, dragonflies eat adult mosquitoes and other insect pests. In effect, the dragonfly is both a larviciding and adulticiding agent.

Cautions to this alternative, however, have been raised by some biologists over whether the transport of dragonfly and damselfly nymphs from one location to another would interfere with local natural populations. The possibility exists that local populations of native dragonflies and damselflies could be harmed by introducing more aggressive, non-native species. Furthermore, since dragonflies eat more than mosquitoes and mosquito larvae, overpopulation could potentially harm populations of other local rare or endangered insects.

Predaceous mosquitoes (a/k/a *Toxorhynchites* sp. mosquitoes) are basically forest mosquitoes. The larval habitats are mainly tree-holes and bamboo, but a few species are found in leaf axils, pitcher plants, rock-pools, and artificial containers. The larvae of all species are predacious. They feed mainly on the larvae of other mosquito species, but exhibit cannibalism in the absence of suitable prey. Males and females both feed exclusively on nectar and other sugary substances. The adults are active during the day.

Predatory mosquito larval survival is dependent upon and limited by prey availability. Predatory mosquito adults will lay their eggs in most types of water-filled containers. However, under natural circumstances, these species do not lay enough eggs to keep pest and vector populations in check. Studies that have used predatory mosquitoes to reduce pest mosquitoes in Florida have relied on rearing and releasing additional adults of *Toxorhynchites* sp. to boost naturally occurring populations and get ahead of pest mosquito production.

Winged Predators

Conservation groups have promoted bats to eliminate mosquitoes from areas where nuisance has become intolerable. This alternative is supported by research conducted in the 1950s indicating that bats released in a room filled with mosquitoes could catch up to 10 mosquitoes per minute. The research was conducted to measure the effectiveness of echo location in insectivorous bat species. The results were extrapolated to suggest that wild bats can consume 600 mosquitoes per

hour. Using that figure, a colony of 500 bats will remove 250,000 mosquitoes each hour and theoretically afford mosquito control for an entire neighborhood. Research since that time, however, has shown that insectivorous bats are opportunistic feeders and mosquitoes make up a very small percentage of their natural diet. Bats' behavior when locked in a room with nothing to feed upon but mosquitoes has no bearing on their behavior in the wild. Bats feed on the same insects that turn up in bug zappers and are no more effective for controlling mosquitoes than their electronic equivalent.

Purple Martins have also been suggested a potential alternative control strategy. However, a review of the scientific and popular ornithological literature leads to a contrary conclusion. Behavior patterns of mosquitoes and martins are such that most mosquitoes are not flying in martin feeding areas when martins are active. Furthermore, most ornithologists realize that mosquitoes form an insignificant portion of the Purple Martin's diet and would agree that the birds play a limited role controlling mosquito populations. If mosquitoes are plentiful, the birds will feed on them, but an adult Purple Martin that is foraging in mosquito territory will accept a dragonfly in place of a mosquito without hesitation. In short, the birds will not significantly diminish mosquito populations.

Mechanical Control Devices

Mechanical control devices are another alternative that could be employed in conjunction with chemical and/or non-chemical controls. The ones most readily utilized are adult trappers, bug zappers, and ultra-sonic systems. Generally, most of these devices are produced for individual consumers. A challenge, therefore, would be deploying such devices on a large, county-wide scale. The following paragraphs explain the operation of the three mechanical devices mentioned.

Mosquito trapping devices are based on generating carbon dioxide (CO_2) to lure adult mosquitoes to the device. Once in the vicinity of the device fan, the mosquitoes are sucked up into a collection bag where they will die. These devices retail for $300 – $1,400 for the initial investment.

The CO_2 baited traps will catch mosquitoes, and have been used at a program level for a very limited, specific purpose. For example, this device has been used as a first line of defense from the migration of mosquitoes from barrier islands. In this example, devices were placed around the perimeter of the island to trap adult mosquitoes prior to them migrating to the mainland. The results have been mixed.

To date, no scientific evidence exists that shows CO_2 baited traps to be effective for actually controlling mosquitoes, reducing their populations, or reducing biting rates under the range of conditions likely to be found in different homes and neighborhoods. Until such time, one must be careful to avoid unrealistic expectations for these devices as an effective mosquito control strategy for individual homes.

Electrocuting devices, popularly known as Bug Zappers, are the most popular device on the market for reducing mosquitoes around the home. Most rely on ultraviolet light to draw insects

through an electrified wire grid. A resounding pop followed by a series of sizzling sounds signals the homeowner that an insect has passed through the electrocuting device. Most homeowners keep the machine on a timer that turns the units off during the daylight hours, but some run the traps day and night during the summer season.

Bug zappers kill a lot of insects, but very few function as pests. Scientific studies indicate that mosquitoes make up a very small percentage of bug zapper collections. In general, biting insects make up less than 1 percent of the insects killed in zappers. Beneficial insects are usually well represented in an average night's catch, too. Most bug-zapper operators may be unaware that the zappers are killing harmless insects that would otherwise serve as food for wildlife. Furthermore, comparison trappings have shown no significant difference in mosquito populations in yards with and without the zappers. So, while this alternative is popular on an individual level, it is obviously not feasible to employ as part of an IPM program.

Finally, hand-held electronic devices that rely on high-frequency sound to repel mosquitoes have become surprisingly popular in recent years. Heavy-duty repellers that claim to keep away spiders, hornets, and rats, in addition to mosquitoes may sell for more than $100. The manufacturer's rationale for using sound as a repelling factor varies from one device to the next. Some claim to mimic the wing beat frequency of a male mosquito. This, supposedly, repels females who have already mated. Others claim to mimic the sound of a hungry dragonfly, causing mosquitoes to flee the area to avoid becoming the predator's next meal.

Most of the electronic repellers on the market hum on a single frequency. Top of the line devices allow for adjustment by the user to achieve the most effective frequency for the mosquito causing the problem. Scientific studies have repeatedly shown that electronic mosquito repellers do not prevent host seeking mosquitoes from biting. Mated female mosquitoes do not flee from amorous males, and mosquitoes do not vacate an area hunted by dragonflies. Electronic mosquito repellers do little in the way of reducing mosquito annoyance.

Chemical Control Techniques (other than fogging)
Chemical control techniques other than fogging do exist. The main two techniques are barrier spraying and misting systems.

The barrier spray is a technique where a pesticide is used to treat the underside of the leaves of foliage surrounding a home or business in order to provide some relief from biting mosquitoes. The rationale behind this technique is that by treating the underside of the foliage the mosquito is robbed of a resting area. Pesticide labels indicate that when not exposed to direct sunlight, the insecticidal activity of this material can last up to 12 weeks after application.

Barrier sprays are labor intensive and often offered as a service from pest control companies. Employing this strategy would not only create the need for additional funding, but also put the County in competition with some private businesses. Furthermore, the chemical application rates per acre for some barrier sprays are more than 14 times higher than the rates used in fogging operations.

A misting system is a timed spray system that can be purchased by homeowners. The systems include insecticide spray nozzles connected by tubing that is installed around fence lines and the perimeter of the house. The tubing is connected to a reservoir of insecticide and the release of the insecticide is regulated by a timer. Proper timing of application is critical.

It can be very difficult to time a mosquito adulticide application that specifically targets resting or flying mosquitoes. Any application that relies on time-released spraying without surveillance and decision making by humans, leads to inappropriate applications. Inappropriate applications can contribute to insecticide tolerance and resistance in insects and may contribute to environmental problems. It is against good mosquito control practices to advocate automatic release of pesticides simply based on a timer.

Personal Protection

Personal protection through the use of repellants and protective clothing is likely the most effective way to reduce bites associated with an adult mosquito population as well as the least intrusive to the general population. As previously mentioned, the Program emphasizes this through its community education component.

Because there are many types of products, many species of mosquitoes, and many factors that affect how well repellents last or work, staff has chosen to include a 1998 report by Mark S. Fradin, MD entitled *Mosquitoes and Mosquito Repellents: A Clinician's Guide* for the Board's information (Attachment #13).

In summary, research over the years has shown that while some alternative control strategies provide limited effectiveness in certain areas, the highly specific biological conditions required for successful application limits the number of areas where these strategies can be utilized. The inability to deploy on a large scale and the inability to ensure consistent results over a broad range of habitats have prevented wide spread adoption into government-run services.

In addition, the "right" environmental conditions for rapid increase of mosquito populations can be expected several times each year in Leon County. It is highly unlikely that any combination of the alternative strategies listed here would be adequate to respond to these population spikes when they occur.

Summary and Potential Program Modifications

In conclusion, based on the research, most programs utilize an Integrated Pest Management strategy which, by definition, incorporates the use of adulticiding as the last measure of protection. Regardless of the option the Board wishes to pursue, staff recommends that a general IPM policy that enumerates the Board's position, as well as provide guidance as to whether the Board wishes staff to continue its no-spray procedures, be adopted. Staff will bring back such a policy once the Board has provided direction.

In addition, regardless of the option the Board pursues, staff recommends that Park and Recreation facilities and/or other types of public gathering areas (i.e. the fairgrounds) be exempt

from any no-spray zone or policy. Such an exemption would allow for these areas to be sprayed for special events, ball games, etc.

Aside from the status quo, the Board may wish to consider one of the following options:

Option 1: Retain the existing program as is which includes: source reduction techniques (mosquito fish and the waste tire program); community education; monitoring and surveillance techniques (Sentinel Chicken program, monitoring trap rates and landing counts, and larval sampling); larviciding; and adulticiding (truck fogging and hand fogging). Continuing the existing service as is would also leave the existing no-spray procedures in place with no change which means turning off foggers in front of no-spray properties.

Option 2: Cease all adulticiding activities (truck fogging and hand fogging) and redirect the existing funds ($282,524) to source reduction, larviciding activities, and the community education program. Implementing this option would have the most significant/negative impact on the rural areas of the county where the opportunities for effective larviciding are minimal.

Option 3: Continue the existing program, but define a specific no-spray buffer at a minimum of 300 feet up to ¼ of a mile radius. In doing so, the County would still have fogging services, but they would be significantly limited once the buffer zones were applied. A 300 foot radius buffer, if enforced with the existing Program's no-spray list, would impact 2,822 parcels; those parcels would no longer have truck fogging or hand fogging services available to them. Utilizing the ¼ mile radius buffer and the existing no-spray list, 14,006 parcels would be impacted. The greatest impact would be on parcels within the urban areas since those areas utilize 80% of the hand-fogging services and 55% of the truck-fogging services.

Option 4: Institute a hybrid model whereby only larviciding activities would be performed in the urban service area and only fogging services would be performed in the rural areas (truck-fogging and hand-fogging). Excluding the urban services area from the adulticiding service completely would impact 93,849 parcels, or 81% of the County's parcels. Obviously, this option again has the greatest impact on the urban area given the fact that no fogging activities would be performed within the urban service area, and that area currently has the highest percentage usage for both fogging activities.

Option 5: Adopt an Integrated Pest Management Policy enumerating the County's intent, purpose, and activities associated with the delivery of Mosquito Control Services. The IMP should further address the Board's decision

regarding no-spray zones and procedures, and exempt Park and Recreation facilities and/or other types of public gathering areas for any no-spray zone to accommodate special events, ball games, and/or other crowd-drawing activities.

Regardless of the option selected from numbers 2-4, Park and Recreation facilities and/or other types of public gathering areas (i.e. the fairgrounds) should be exempt from any no-spray zone or policy to accommodate special events, ball games and/or other crowd-drawing activities.

Options:

Option 1: Retain the existing program as is which includes: source reduction techniques (mosquito fish and the waste tire program); community education; monitoring and surveillance techniques (Sentinel Chicken program, monitoring trap rates and landing counts, and larval sampling); larviciding; and adulticiding (truck fogging and hand fogging). Continuing the existing service as is would also leave the existing no-spray procedures in place with no change which means turning off foggers in front of no-spray properties.

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Option 5: Adopt an Integrated Pest Management Policy enumerating the County's intent, purpose, and activities associated with the delivery of Mosquito Control Services. The IMP should further address the Board's decision regarding no-spray zones and procedures, and exempt Park and Recreation facilities and/or other types of public gathering areas for any no-spray zone to accommodate special events, ball games, and/or other crowd-drawing activities.

Option 6: Board Direction

Recommendation:
Board Direction on Options #1-#4.
Adopt Option #5.

Attachments:

1. November 10, 2009 Agenda Item
2. Cover memo to the Science Advisory Committee
3. Mosquito Control Agencies/Programs Listing
4. Prevention and Personal Protection Web Page
5. Mosquito Control Community Education and Information Web Page
6. Mosquitoes Make Terrible Neighbors flier
7. EPA Questions & Answers: Pesticides and Mosquito Control
8. Survey Instrument regarding no-spray policies
9. Delaware Mosquito Control Spray Policy
10. City of Winnipeg Adult Mosquito Control Policy
11. Maps depicting 300 foot and ¼ mile buffer zones
12. Powerpoint Presentation Slides from Dr. Eric Schreiber, Sarasota County Mosquito Control Management Services
13. *Mosquitoes and Mosquito Repellents: A Clinician's Guide*

PA/AR/TP/DW/GPandLD/ld

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ATTACHMENT # 1
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Board of County Commissioners

Leon County, Florida
www.leoncountyfl.gov

Agenda Item
Executive Summary

Tuesday, November 10, 2009

Title: Review and Consideration of the Current "Mosquito Control No-Spray Program"
Staff: Parwez Alam, County Administrator Alan Rosenzweig, Assistant County Administrator Tony Park, P.E., Director of Public Works

Issue Briefing:
This item presents information regarding the County's existing "Mosquito Control No-Spray Program" and seeks Board direction regarding changes and/or modifications to the program.

Over the years, the Mosquito Control Program has searched for ways to address the concerns of citizens who, for one reason or another, are opposed to the fog truck program. These reasons are often unique to the individual and can range from concerns about the environment to health and safety issues. Historically, Mosquito Control has handled each request on a case-by-case basis.

Conflicts sometimes arise between persons who are opposed to mosquito control spraying and nearby neighbors demanding the spraying for pest relief. In the past, when such conflicts arose, staff has been able to resolve the conflicts in a manner acceptable to all parties. The current no-spray program, which has been in effect for more than 15 years, is an informal program that was developed to address citizens' concerns about the spray program, and assist in the process of conflict resolution. Due to recent conflicts within the Orchard Walk Subdivision concerning a planned fog-truck spraying, it has become apparent that an informal process responding to "no-spray" requests may no longer be a sufficient practice for the County. Staff is seeking the Board's direction.

Fiscal Impact:
The fiscal impact of the item will vary depending upon the Board's direction. For example, implementing a new notification process would have an increase in the operating cost of the program, while eliminating portions of the Mosquito Control program would present a cost savings to the County.

Staff Recommendation:
Board Direction.

ATTACHMENT # 1
PAGE 2 OF 6

Report and Discussion

Background:

The current no-spray program, which has been in use for more than 15 years, is an informal program that was developed to address citizens' concerns about the spray program and assist in the process of conflict resolution.

As early as 1996, the staff began working with the residents of Orchard Walk Subdivision to resolve conflicts involving mosquito control services. In situations where a requested no-spray had infringed on another neighbor's desire to have his/her property sprayed, staff was able to offer the hand-fogging service. In most cases, this satisfied both parties and reduced disputes over the fog truck program within the subdivision.

The 2004 adoption of the fee-for-service for the hand fogging, once again triggered a confrontation between Orchard Walk residents. Staff was faced with a situation where two parties were unable to agree on a compromise through the informal process.

It was suggested, at that time, that a no-spray buffer be established around requesting residents to prevent the drift of insecticide onto their property. An analysis in 2004 revealed that if a ¼-mile or ½-mile no-spray buffer was established around a parcel on Summerlin Drive, then an additional 160 parcels or 481 parcels, respectively, would be excluded from receiving the fog truck service. Staff felt that this placed an unreasonable burden on surrounding residents who were requesting mosquito control services.

As a result, a procedure unique to Orchard Walk Subdivision was established. Residents within Orchard Walk Subdivision who requested to be on the no-spray list would receive 48 hours advance notice of planned fog truck operations. Since that time, this is the process staff has followed for this particular subdivision. Staff has invited Dr. Termotto, an Orchard Walk resident, to provide information regarding his concerns relating to the truck fogging
(Attachment #1). In addition, Dr. Termotto will be prepared to make a presentation at the Commission meeting.

To provide the Board additional information on mosquito control programs, staff has invited representatives from the State Bureau of Entomology and Pest Control to present information at the meeting.

Due to recent conflicts within the Orchard Walk Subdivision concerning a planned fog-truck spraying, it has become apparent that the informal process responding to "no-spray" requests may no longer be a sufficient practice for the County. Staff is seeking the Board's direction.

Analysis:

The Mosquito Control Program (Program), within the Division of Operations, utilizes an Integrated Pest Management (IPM) program to control mosquitoes in Leon County. IPM is an approach to pest control that utilizes regular monitoring to determine if and when treatments are needed, and employs physical, mechanical, cultural, biological, chemical, and educational strategies in an effort to reduce mosquito populations and mosquito-borne illnesses.

The first lines of defense for mosquito control are to use environmentally-sound source reduction techniques to disrupt the mosquito's life cycle or stocking of mosquitofish in stormwater basins, backyard ornamental ponds, etc. The Program has a long-term commitment for implementing such approaches and is carrying out this approach as time and resources permit. In some cases, however, staff may be unable to undertake the activities needed for source reduction purposes resulting in the need for other control measures to be employed.

The alternative method for control is selective application of environmentally compatible, EPA-registered larvicides (products designed to kill mosquitoes while they are still in the concentrated aquatic life stage) applied to the areas where mosquitoes breed. Ground-applied larvicides are used in urban areas to treat roadside ditches, flooded fields, abandoned tire piles, abandoned swimming pools, woodland pools, swales, lawn puddles, etc.

Aerial larviciding by helicopter is primarily used to treat freshwater wetlands, flooded woodlands, or swamps, and is done only as warranted based upon intensive field surveys of larval occurrence, distribution, and abundance. To be effective, larvicides must be applied during a very restricted period in the mosquito's aquatic phase of development. However, unfavorable weather may prevent effective larvicide applications during this period.

When unfavorable larviciding conditions occur or larviciding has been unsuccessful, it might be necessary to resort to adulticiding (the term used to describe spraying practices to control adult mosquitoes). This involves the ground application of adulticide applications with truck mounted fog units. The adulticides used for the control of pestiferous mosquito species are EPA-registered insecticides, which have demonstrated minimal human health or environmental risks, and, as such, can be sprayed over or within populated areas. The EPA has determined that mosquito control insecticides can be used to kill mosquitoes without posing unreasonable risks to human health, wildlife, or the environment.

The best available scientific information from the EPA and product manufacturers, plus independent research by other sources, leads staff to conclude that the products used by the County, and the manner in which they are used, pose no unacceptable risks to the public, wildlife, or the environment. The EPA's product-labeling process reflects the permitted use and safety precautions that pesticide applicators must follow. The EPA, in order to designate a product's approved use, has to complete a risk assessment, and has to determine that the final end use possesses extremely low human health or environmental risks when applied in accordance with federally approved label instructions.

The decision to spray for adult mosquitoes is based upon evidence indicating that mosquito populations are unacceptably high. Except when there are additional reasons to believe that some mosquito species may be presenting a significant public health risk, no spraying is conducted unless trap counts or complaint evidence suggests that spraying is warranted. Adult mosquito light-trap data or adult mosquito landing rate counts, which indicate a nuisance condition as well as an enhanced possibility for mosquito-borne disease transmission, may indicate that spraying is warranted. In addition, requests for spraying coming from either individuals, civic or homeowners associations or designated representatives may be used to decide whether spraying is warranted. The Mosquito Control Program assumes that timely and safe adulticiding is allowable and desired whenever pest populations become excessive or mosquito-borne disease potentially threatens.

To the extent feasible and practical, adulticide spraying is conducted at times that minimize direct human exposure. The fog trucks usually operate Monday through Friday evenings, between dusk and up to four hours after dusk. In the event that inclement weather or other circumstances prevent adulticiding at these times, spraying may be conducted during the weekend evening hours. Ground applications will only be done when weather conditions comply with product-label spraying requirements (e.g. clear visibility and winds less
than 10 mph).

The EPA approved label for Anvil states a swath width of 300 feet should be used for calibration of the fog trucks. The spray will drift further than 300 feet, but it is in the first 300 feet that the spray is most effective. As the spray drifts further away from the truck, it becomes less effective due to the loss of droplets that have deposited on buildings, vegetation, mosquitoes, etc.

No-Spray Program
Over the years, the Mosquito Control Program has searched for ways to address the concerns of citizens who, for one reason or another, are opposed to the fog truck program. These reasons are often unique to the individual and can range from concerns about the environment to health and safety issues. Historically, staff has handled each request on a case-by-case basis.

Conflicts sometimes arise between persons who are opposed to mosquito control spraying and nearby neighbors demanding the spraying for pest relief. In the past, when such conflicts arose, staff has been able to resolve the conflicts in a manner acceptable to all parties. The current no-spray program, which has been in use for more than 15 years, is an informal program that was developed to address citizens' concerns about the spray program and assist in the process of conflict resolution.

There are approximately 122 identified, no-sprays in Leon County; these areas range from individual homes to entire neighborhoods. A map showing these locations is included as Attachment #2. The no-sprays can be broken down into the following four broad categories: Call Before Spraying; Do Not Spray Subdivision; Do Not Spray Property/Area; and, 48-Hour Written Notification.

Call Before Spraying - This category is created when a resident has physical/health concerns about the spraying, but does not mind the property being sprayed. These individuals have requested to be notified by telephone of when the County will be spraying in their neighborhood so that they may take adequate precautions. Those precautions may include closing their windows to prevent the spray from entering their homes, or postponing outdoor activities to reduce the risk of being exposed to the spray. Currently, 15 residents have requested to be called before spraying.

Do Not Spray Subdivision - The "Do Not Spray Subdivision" is in response to situations where residents of a subdivision have directed their homeowners association to request, in writing, that spraying with the fog truck not be conducted within their neighborhood. Generally, there are two types of situations found under this category.

The first type involves the total ban of all adult mosquito spraying within the subdivision. These subdivisions include Miccosukee Land Co-op and NWK Co-op Plantation and Sunrise Homeowners Association. The second type includes subdivisions that have requested that the fog trucks not be used within the subdivision, but do allow the use of hand foggers on individual properties at the request of the homeowners. This type includes Lake Breeze Subdivision.

Do Not Spray Property/Area - This is the most common type of no-spray and represents those residents who have requested that their property not be sprayed with the fog truck. This usually involves simply turning the sprayer off before reaching the individual's property and turning the sprayer back on once the truck has passed the property. The reasons for these requests have included the following: pregnancy, beehives, allergies, fishponds, organic gardens, backyard wildlife refuges, and/or an aversion to all pesticides. Currently, 103 different parties fall into this category.

48 Hour Written Notice – Currently, there is only one location that warrants the use of a 48-hour written notice prior to spraying with the fog truck. This is Orchard Walk Subdivision. This procedure was established in 2004, by staff, in response to correspondence between Mr. John H. Fairhart, Esq. (Attachment #3), the County Attorney's Office (Attachment #4), and the County Administrator's Office (Attachment #5).

In the event of an Eastern Equine Encephalitis (EEE), St. Louis Encephalitis (SLE), West Nile Encephalitis (WNE), or other mosquito-borne public health emergencies, declared by the Leon County Health Department and/or the State of Florida, general public health considerations to prevent or lessen serious disease problems must take precedent over individual desires to avoid a short-term exposure to an insecticide that is registered by the EPA for application in populated areas. In these cases, public health concerns may necessitate deviations from regular notification/advance notice procedures as experienced immediately following Tropical Storm Fay in 2008.

Dr. Termotto and representatives from the State Bureau of Entomology and Pest Control will be prepared to make presentations at the Board meeting.

Staff is requesting Board direction regarding whether the current notification process should be continued and/or formalized; modified; or discontinued. Alternatively, the Board may choose to revisit whether eliminating the truck-fogging portions of the Mosquito Control program would be the best direction for the County due to the divergent positions that exist within the community.

Options:

1. Direct staff to formalize the existing notification process and develop a policy for Board consideration.
2. Direct staff to eliminate the truck spraying/fogging program, while continuing the individual home hand-spraying program, monitoring and larviciding activities, and educational efforts.
3. Board Direction.

Recommendation:

Board Direction.

Attachments:

1. Attachments from Dr. Termotto
1A. Additional Information from Dr. Termotto
2. Map of identified no-spray locations
3. Letter from John H. Fairhart
4. Letter from County Attorney
5. Letter from County Administrator

Additional Information
Additional Information
Additional Information

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BOARD OF COUNTYCOMMISSIONERS
MEMORANDUM

DATE: January 5, 2010

TO: Leon County Science Advisory Committee

FROM: Tony Park, P.E., Director of Public Works

SUBJECT: Mosquito Control Program

Issue Briefing:

On November 10, 2009, Public Works staff presented an agenda item to the Board for direction regarding the County's Mosquito Control program (Attachment #1). The item was prepared as a result of conflicts that have arisen between persons opposed to mosquito spraying versus others in the same neighborhood demanding fogging services for pest relief.

Conflicts like this have occurred in the past and have been reviewed by the Science Advisory Committee (i.e. 2001) (Attachment #2), but have been previously resolved by addressing them on a case by case basis and instituting an informal no-spray procedure for County staff to follow. In the most recent conflict, however, it became apparent that an informal process may no longer be sufficient for the County. Furthermore, some concerned citizens at the November 10 meeting asked the Board to cease spraying/fogging practices completely (Attachment #3).

During the discussion that ensued by the Commission, staff was asked to present the information regarding mosquito control practices to the Leon County Science Advisory Committee (SAC) for its insights and/or opinions. Public Works staff will be conducting a workshop with the Board on February 9 from 1:00 pm – 3:00 pm. Staff will be addressing the Integrated Pest Management System, making comparisons to other programs, exploring alternative control strategies (to that of fogging), and making recommendations regarding the continuation of the Program.

Background:

The Leon County Mosquito Control Program (Program), within the Division of Operations, utilizes an Integrated Pest Management (IPM) program to control the mosquito population. IPM utilizes regular monitoring to determine if and when treatments are needed and employs physical, mechanical, cultural, biological, chemical and educational strategies in an effort to reduce mosquitoes and mosquito-borne illnesses.

The first lines of defense for Leon County's Program are to use environmentally-sound source reduction techniques to disrupt the mosquito's life cycle or stocking of mosquitofish in stormwater basins, backyard ornamental ponds, etc. In some cases, however, staff may be unable to undertake the activities needed for source reduction purposes resulting in the need for

other control measures to be employed.

The alternative method for control is selective application of environmentally-compatible, EPA-registered larvicides (products designed to kill mosquitoes while they are still in the concentrated aquatic life stage) applied to the areas where mosquitoes breed. Ground-applied larvicides are used in urban areas to treat roadside ditches, flooded fields, abandoned tire piles, abandoned swimming pools, woodland pools, swales, lawn puddles, etc.

Aerial larviciding by helicopter is primarily used to treat freshwater wetlands, flooded woodlands, or swamps, and is done only as warranted based upon intensive field surveys of larval occurrence, distribution and abundance. To be effective, larvicides must be applied during a very restricted period in the mosquito's aquatic phase of development. However, unfavorable weather may prevent effective larvicide applications during this period.

When unfavorable larviciding conditions occur or larviciding has been unsuccessful, it might be necessary to resort to adulticiding (the term used to describe spraying practices to control adult mosquitoes). This involves the application of adulticides with truck mounted fog units. The adulticides used for the control of pestiferous mosquito species are EPA-registered insecticides, which have demonstrated minimal human health or environmental risks, and as such can be sprayed over or within populated areas (Attachment #4). The EPA has determined that mosquito control insecticides can be used to kill mosquitoes without posing unreasonable risks to human health, wildlife or the environment.

The best available scientific information from the EPA and product manufacturers, plus independent research by other sources, leads staff to conclude that the products used by the County, and the manner in which they are used, pose no unacceptable risks to the public, wildlife or the environment. The EPA's product-labeling process reflects the permitted use and safety precautions that pesticide applicators must follow (Attachments #5 and #6). The EPA, in order to designate a product's approved use, has to complete a risk assessment, and has to determine that the final end use possesses extremely low human health or environmental risks when applied in accordance with federally-approved label instructions.

The decision to spray for adult mosquitoes is based upon evidence indicating that mosquito populations are unacceptably high. Except when there are additional reasons to believe that some mosquito species may be presenting a significant public health risk, no spraying is conducted unless trap counts or complaint evidence suggests that spraying is warranted. To the extent feasible and practical, adulticide spraying is conducted at times which minimize direct human exposure. The fog trucks usually operate Monday through Friday evenings between dusk and up to four hours after dusk. In the event that inclement weather or other circumstances prevent adulticiding at these times, spraying may be conducted during the weekend evening hours.

Requests for the Science Advisory Committee

1. Review the original agenda item presented to the Board on November 10 and the attachments from both staff and concerned citizens.
2. Send a representative to the February 9, 2010, workshop to gain a better understanding of the issues at hand and Board's intentions for SAC involvement.
3. Report insights and/or opinions back to the Board by March 12, 2010 prior to the beginning of the mosquito season.

LD/ld

cc: Alan Rosenzweig, Assistant County Administrator
Dale Walker, Director of Operations

Attachments:

1. November 10, 2009 Agenda Item
2. 2002 Memo from the Science Advisory Committee
3. Documents provided by Dr. Termotto
4. EPA Questions & Answers: Pesticides and Mosquito Control
5. Anvil Material Safety Data Sheet
6. Anvil Sample Label

Mosquito Control Agencies

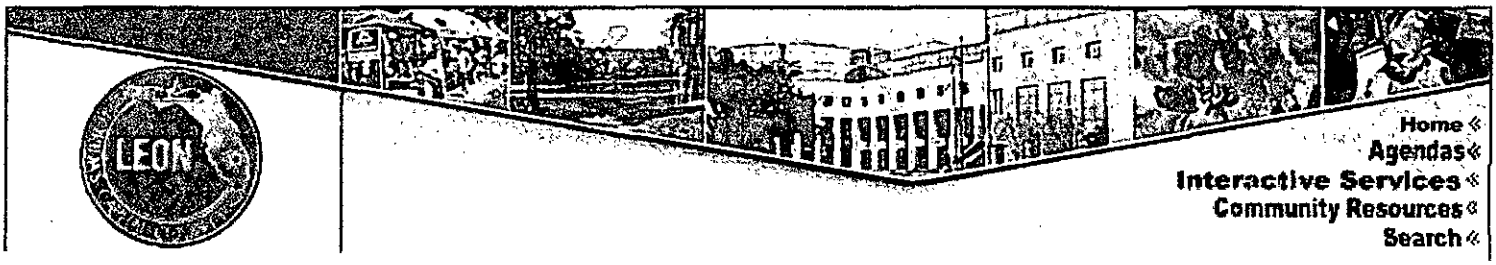
(as represented by DACS and the Official List of Special Districts)

Program	County	Type
Amelia Island Mosquito Control District	Nassau	Independent District
Anastasia Mosquito Control District	St. Johns	Independent District
Bay County Mosquito Control	Bay	Dependent District
Beach Mosquito Control District	Bay	Independent District
Bradford County Mosquito Control	Bradford	BOCC
Brevard Mosquito Control District	Brevard	Dependent District
Broward County Mosquito Control	Broward	BOCC
Buckhead Ridge Mosquito Control	Glades	Independent District
Calhoun County Mosquito Control	Calhoun	BOCC
Charlotte County Environmental & Extension Services	Charlotte	BOCC
Citrus County Mosquito Control District	Citus	Independent District
Clay County Mosquito District	Clay	Dependent District
Collier Mosquito Control District	Collier	Independent District
Columbia County Mosquito Control	Columbia	BOCC
DeSoto County Mosquito Control	DeSoto	Dependent District
Dixie County Mosquito Control	Dixie	
East Flagler Mosquito Control District	Flagler	Independent District
East Volusia Mosquito Control District	Volusia	Dependent District
Escambia County Mosquito And Rodent Management Division	Escambia	BOCC
Florida Keys Mosquito Control District	Monroe	Independent District
Fort Myers Beach Mosquito Control	Lee	Independent District
Franklin County Mosquito Control	Franklin	BOCC
Gadsden County Mosquto Control	Gadsden	BOCC
Gulf County Mosquito Control	Gulf	BOCC
Hendry County Mosquito Control District	Hendry	Dependent District
Hernando County Mosquito Control	Hernando	BOCC
Hillsborough Coutny Mosquito Control	Hillsborough	BOCC
Holmes County Mosquito Control District	Holmes	
Indian River Mosquito Control District	Indian River	Independent District
Jackson County Mosquito Control	Jackson	
Jacksonville Mosquito Control	Duval	BOCC
Jefferson County Health Department	Jefferson	Health Department
Lake County Mosquito/Aquatic Plant Mangement	Lake	BOCC
Lee County Mosquito Control District	Lee	Independent District
Leon County Mosquito Control	Leon	BOCC
Levy County Mosquito Control	Levy	BOCC
Liberty County Mosquito Control	Liberty	BOCC
Madison County Mosquito Control	Madison	BOCC
Manatee County Mosquito Control District	Manatee	Independent District
Martin County Mosquito Control District	Martin	BOCC
Miami-Dade County Mosquito Control	Miami-Dade	BOCC
Moore Haven Mosquito Control District	Glades	Independent District
North Walton Mosquito Control	Walton	Dependent District
Okaloosa County Mosquito Control	Okaloosa	BOCC
Orange County Mosquito Control	Orange	BOCC
Osceola County Mosquito Control	Osceola	BOCC
Palm Beach County Mosquito Control	Palm Beach	BOCC
Pasco County Mosquito Control District	Pasco	Independent District
Pinellas County Mosquito Control	Pinellas	Dependent District
Polk County Mosquito Control	Polk	BOCC
Putnam County Mosquito Control	Putnam	BOCC

Mosquito Control Agencies

(as represented by DACS and the Official List of Special Districts)

Program	County	Type
Santa Rosa County Mosquito Control	Santa Rosa	BOCC
Sarasota County Mosquito Control District	Sarasota	Dependent District
Seminole County Mosquito Control	Seminole	
South Walton County Mosquito Control District	Walton	Independent District
St. Lucie County Mosquito Control District	St. Lucie	Dependent District
Sumter County Mosquito Control	Sumter	BOCC
Taylor County Mosquito Control	Taylor	BOCC
Wakulla County Mosquito Control	Wakulla	BOCC
Washington County Mosquito Control	Washington	Health Department
West Florida Mosquito Control District	Flagler	BOCC
Jackson County Mosquito Control	Flagler	BOCC



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Prevention And Personal Protection

Source Reduction

The best method of controlling mosquitoes and the diseases some carry is by source reduction; that is, by eliminating the places mosquitoes breed. Mosquitoes are hardy and need very little water to lay eggs and hatch into biting adults. The amount held in a fallen magnolia leaf, plant saucers, pet dishes, bird baths, ponds and plastic chairs can be the source of hundreds of the pesky arthropods. By keeping anything that holds water emptied or flushed with clean water every two or three days, the likelihood of breeding mosquitoes is greatly reduced.

Old tires are a prime source of breeding mosquitoes. Mosquito Control has a **Tire Recycling Program** available to all residents. Up to four tires will be removed from a residential property by a Mosquito Control technician upon request.

Property inspections for residential and businesses are conducted by request to help locate places where mosquitoes are breeding. Technicians will advise residents about eliminating sources of breeding sites and appropriate treatments are applied.

Tips on eliminating mosquito breeding sites:

- Clean out eaves, troughs and gutters, wherever leaves or pine needles collect.
- Remove old tires or drill holes in those used in playgrounds to drain.
- Turn over or remove empty plastic pots.
- Pick up all beverage containers and cups.
- Check tarps on boats or other equipment that may collect water.
- Pump out bilges on boats.
- Replace water in birdbaths and pet or other animal feeding

dishes at least once a week.

- Change water in plant saucers, including hanging plants, at least once a week.

- Remove vegetation or obstructions in drainage ditches that prevent the flow of water.

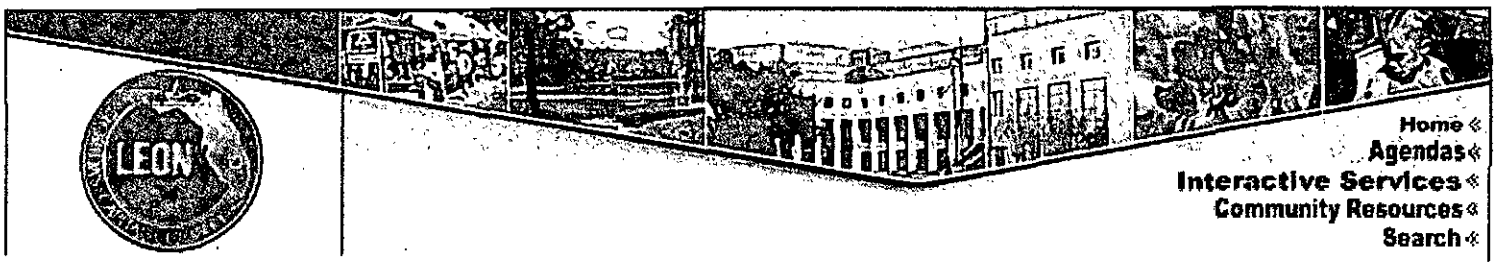
Personal Protection

Individuals planning to be outdoors during times of mosquito activity are advised to protect themselves from biting mosquitoes with the use of repellents. The Centers for Disease Control and Prevention recommend effective mosquito repellents that contain as the active ingredient DEET, Oil of Lemon/Eucalyptus, or Picaridin that are found in widely available over the counter products. Follow the application directions carefully and check the labels for restrictions of use for infants and children.

There are steps you can take to reduce the likelihood of mosquito bites. These should include the **"5 D's" for prevention:**

- **Dusk** and **Dawn** -- Avoid being outdoors when mosquitoes are seeking blood, for many species this is during the dusk and dawn hours.
  Dress -- Wear clothing that covers skin.
  DEET -- When the potential exists for exposure to mosquitoes, repellents containing DEET (N,N-diethyl-meta-toluamide, or N,N-diethyl-3-methylbenzamide), Oil of Lemon/Eucalyptus or Picaridin are recommended. Products with concentrations up to 30% DEET are generally recommended for most situations. (It is not recommended to use DEET on children less than 2 months old. Instead, infants should be kept indoors or mosquito netting used over carriers when mosquitoes are present). If additional protection is necessary, apply a permethrin repellent directly to your clothing. Always read the manufacturer's directions carefully before you put on a repellent.
  Drainage -- Check your home to rid it of standing water in which mosquitoes can lay their eggs. Elimination of breeding sites is one of the keys to prevention.

Leon County Mosquito Control
501 Appleyard Dr, Suite A
Tallahassee, FL 32304
Telephone: 850-606-2200
Fax: 850-606-2201



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Mosquito Control Community Education And Information

Education plays a major role in Leon County Mosquito Control. The main focus is source reduction with the mission of "Finding Them before They Find You." Using live models, non-static exhibits and lively presentations, knowledge of how everyone who lives in Leon County can find mosquito breeding sites and what to do about them is increased. The outcome encourages a partnership between Mosquito Control and residents in the fight against mosquitoes.

In addition to presentations to adult groups, organizations, business, homeowners and neighborhood associations, Mosquito Control has developed educational programs for school children from grades three through high school. When everyone does their part in eliminating places where mosquitoes breed in their yards and neighborhoods, we can all enjoy our outdoor time more and lessen the incidence of the diseases some mosquitoes carry.

Please visit these web pages to learn more

History and Facts About Mosquito Control

Community Outreach: Find contact information to schedule a presentation to adult groups.

School and Youth Programs: Learn classroom teacher opportunities, student research opportunities, program focus and materials.
Link to Mosquito Menace video

Personal Protection
Individuals working or playing in mosquito-infested areas will find repellents helpful in preventing mosquito bites.

Remember the "Five D's" of actions you can take to protect yourselves from biting mosquitoes.
Dusk & Dawn – Stay indoors when mosquitoes are biting
Dress - Wear clothing that protects your skin from bites. Long sleeves and long pants are best. Mosquitoes will find uncovered spots to bite.
Drain – Empty or flush with clean water every three days, all containers holding water around your property.
DEET - Use a mosquito repellent containing DEET and follow directions carefully. Cover the area of skin to be treated carefully. Use repellent on outer clothing as well as skin. Keep repellents away from eyes, nostrils and lips. Check with your child's doctor before applying repellent to an infant or small child. Other CDC-recommended repellents include picaridin and oil

of lemon/eucalyptus.

Myths and Facts about Mosquitoes
Myth: Both female and male mosquitoes bite
Fact: Only the female mosquito bites. She uses the protein from your blood to develop her eggs. The male mosquito feeds on nectar from flowers.

Myth: All mosquitoes carry disease.
Fact: Only a few species of mosquitoes pose a health threat in Leon County.

Myth: The mosquito dies after she bites you.
Fact: Mosquitoes are capable of biting more than once. After the female mosquito takes a blood meal and completes the development of her eggs, numbering up to 200, she may then seek another blood meal to develop more eggs.

Myth: Mosquitoes can transmit HIV/AIDS
Fact: There is no scientific evidence to support the theory that mosquitoes can transmit
the HIV virus.

Myth: Only the female mosquito makes a buzzing sound
Fact: The buzzing sound you hear is from the beating of the wings. Both female and
male wings make a buzzing sound. Most people don't hear the male mosquito because it doesn't bite.

Myth: Bats and Purple Martin birds are very effective at controlling mosquitoes
Fact: Bats and Purple Martins are indiscriminate feeders and will eat any sort of insect that flies by. Since they don't concentrate on mosquitoes, they rarely have any substantial effect on the mosquito population.

Myth: Bug zappers are good for controlling mosquitoes
Fact: Bug zappers kill many kinds of insects, including beneficial ones. Bug zappers do more harm than good.

Mosquitoes Make Terrible Neighbors brochure

Classroom workbook (Grades 4 & 5)
(PDFs, requires an appropriate reader)

Source Reduction

The most effective way to control mosquitoes is to find and eliminate their breeding sites. Eliminating large breeding areas such as swamps or sluggishly moving streams or ditches requires community-wide efforts. Permanent source reduction measures include ditching, and draining swampy mosquito breeding areas.

Residents can take the following steps to prevent mosquito breeding on their own property:

1. Dump out or dispose of tin cans, old tires, buckets, plastic swimming pools or other containers that collect and hold even small amounts of water. Do not allow water to accumulate at the base of flower pots or in pet dishes for more than 2 days.

2. Clean debris from rain gutters. Check around faucets and air conditioner units and repair leaks to eliminate standing water. Rake up fallen magnolia tree leaves and bag or compost.

3. Change water in bird baths and wading pools at least twice a week and stock ornamental pools with mosquito fish provided by Mosquito Control.

4. Remove, drain or fill tree holes and stumps with mortar, or flush with clean water weekly.

5. Eliminate seepage from cisterns, cesspools, and septic tanks.

6. Eliminate standing water around animal watering troughs and flush troughs with fresh water weekly.

7. Irrigate lawns and gardens only when necessary, to prevent water from standing for several days. Check low spots in yard and fill to eliminate standing water.

8. Keep weeds and lawn trimmed and mowed.

Leon County Mosquito Control
501 Appleyard Dr, Suite A
Tallahassee, FL 32304
Telephone: 850-606-2200
Fax: 850-606-2201

FIND THEM BEFORE THEY FIND YOU!

Find *all* sources of standing water. You might be surprised where they are. Homeowners and renters, even apartment-dwellers should check:

- Pet dishes
- Plants and plant saucers
- Birdbaths
- Reflecting ponds
- Old tires
- Trash container lids

Keep them emptied and keep mosquitoes away!

What Mosquito Control Can Do For You

Inspect your property for places where mosquitoes breed.

Treat places like low-lying areas, ditches, ponds with larvacides to prevent adult mosquitoes from forming.

Hand-spray vegetation and other adult mosquito refuges on a property. The first two hand sprayings are free; additional sprays are $25 each, payable by check or credit card.

*Spray large properties, streets and neighborhoods by trucks for uniform coverage of an area. The common name for this kind of spraying is "the fogger truck."

Provide you with free mosquito fish for a pond or reflecting pool. They feed on mosquito larvae and require little care.

Individuals who prefer not to have their property sprayed or who wish to be notified before their street is truck-sprayed can contact LCMC for these services. Technicians make reasonable efforts to comply with these requests.

MOSQUITOES MAKE TERRIBLE NEIGHBORS

LEON COUNTY
MOSQUITO CONTROL
501 Appleyard Drive Ste. A
Tallahassee, FL 32304
606-2200

www.leoncountyfl.gov

ATTACHMENT # 6
PAGE 1 OF 2

CENTER FOR DISEASE CONTROL AND PREVENTION (CDC) RECOMMENDATIONS FOR USE OF INSECT REPELLENTS

- Apply repellent only to exposed skin or clothing.
- Do not apply to eyes or mouth and use sparingly around ears. If using spray, do not spray directly on face. Spray on hands first and then apply to face.
- Do not allow children to handle the product. When using on children, apply to your own hands first, then on the child. Avoid putting on child's hands.
- Use just enough repellent to cover exposed skin and/or clothing. Heavy applications are normally unnecessary. If biting insects continue, apply an additional thin layer.
- When returning indoors, wash treated skin with soap and water. Also wash treated clothing before wearing again.
- Use repellent containing DEET, picaridin, or oil of lemon/eucalyptus, widely available in many forms. Apply sparingly according to label.

Why Mosquito Control Works so Hard for You

Leon County is a beautiful place to live. Nature, people and animals all peacefully co-exist for the most part.

Mosquitoes can interrupt the balance of humans and environment by introducing serious diseases into people and animals. It's the job of Mosquito Control to find and eliminate mosquitoes before they become a major health hazard.

Technicians continually check sites all over the county for larva, the first stage of mosquito breeding and treat the areas to prevent hatching.

Sentinel chickens are tested for evidence of West Nile Virus and Eastern Equine Encephalitis.

Controlling mosquitoes before they become biting adults is the main goal of Leon County Mosquito Control.

Did You Know?

Myths and Facts about mosquitoes

Do mosquitoes like you?
Mosquitoes are attracted to humans because of the carbon dioxide you exhale.

*Other chemicals in your breath and on your skin also attract them.
*The color, texture, temperature and moisture in your skin is a factor.
*Certain soaps, perfumes, hair treatments, lotions and personal care items all have chemicals in them that attract biting insects.
*There is no scientific evidence that eating garlic, vitamins, onions or any other food will make you immune to mosquitoes.

There are more than 3,000 species of mosquitoes throughout the world.
*More people have died from mosquito-borne diseases than have died in all the wars ever fought.
*Mosquitoes are one of the oldest life forms on earth.
*In warm weather mosquitoes only need 3 1/2 days to grow from egg to adult.

Birds and bats, while desirable, t will not reduce the number of mosquitoes in your yard.
*Expensive and popular electric bug zappers kill many more beneficial insects than mosquitoes. In fact, the zappers attract many more mosquitoes into your yard.

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United States Environmental Protection Agency | Prevention, Pesticides and Toxic Substances (7506C) | May 2000

EPA Questions & Answers

Pesticides and Mosquito Control

Mosquito-borne diseases affect millions of people worldwide each year. In the United States, some species of mosquitoes can transmit diseases such as encephalitis, dengue fever, and malaria to humans, and a variety of diseases to wildlife and domestic animals. To combat mosquitoes and the public health hazards they present, many states and localities have established mosquito control programs. These programs, which are based on surveillance, can include nonchemical forms of prevention and control as well as ground and aerial application of chemical and biological pesticides.

The mission of the Environmental Protection Agency (EPA) is to protect human health and the environment. EPA reviews and approves pesticides and their labeling to ensure that the pesticides used to protect public health are applied by methods which minimize the risk of human exposure and adverse health and environmental effects. In relation to mosquito control, the Agency also serves as a source of information about pesticide and non-pesticide controls to address the concerns of the general public, news media, and the state and local agencies dealing with outbreaks of infectious diseases or heavy infestations of mosquitoes. The following questions and answers provide some basic information on mosquito control, safety precautions, and information on insecticides used for mosquito control programs.

1. How does EPA ensure the safest possible use of pesticides?

EPA must evaluate and register pesticides before they may be sold, distributed or used in the United States. The Agency is also in the process of reassessing and when appropriate, reregistering all older pesticides (registered prior to 1984) to ensure that they meet current scientific standards. To evaluate a pesticide for either registration or re-registration, EPA assesses a wide variety of potential human health and environmental effects associated with use of the product. The producer of the pesticide must provide data from tests done according to EPA guidelines. These tests determine whether a pesticide has the potential to cause adverse effects on humans, wildlife, fish and plants, including endangered species and non-target organisms. Other tests help to assess the risks of contaminating surface water or groundwater from leaching, runoff or spray drift. If a pesticide meets EPA requirements, the pesticide is approved for use in accordance with label directions. **However, no pesticide is 100 percent safe and care must be exercised in the use of any pesticide.**

2. How are mosquitoes controlled with pesticides and other methods?

The first step in mosquito control is surveillance. Mosquito specialists conduct surveillance for diseases harbored by domestic and non-native birds, including sentinel chickens, and mosquitoes. Surveillance for larval habitats are conducted using maps, aerial photographs, and by evaluating larval populations. Other techniques include various light traps, biting counts; and analyzing reports by the public. Mosquito control programs also put high priority on trying to prevent a large population of adult mosquitoes from developing, so that additional controls may not be necessary. Since mosquitoes must have water to breed, methods of prevention may include controlling water levels in lakes, marshes, ditches, or other mosquito breeding sites, eliminating small breeding sites if possible, and stocking bodies of water with fish species that feed on larvae. Both chemical and biological measures may be employed to kill immature mosquitoes during larval stages. *Larvicides* target larvae in the breeding habitat before they can mature into adult mosquitoes and disperse. Larvicides include the bacterial insecticides *Bacillus thuringiensis israelensis* and *Bacillus sphaericus*, the insect growth inhibitor methoprene, and the organophosphate insecticide temephos. Mineral oils and other materials form a thin film on the surface of the water which cause larvae and pupae to drown. Liquid larvicide products are applied directly to water using back-pack sprayers and truck or aircraft-mounted sprayers. Tablet, pellet, granular and briquet formulations of larvicides are also applied by mosquito controllers to breeding areas.

Key Tools in Combating Mosquitoes

Public education and prevention around the home – eliminating mosquito breeding habitats (any standing water) around the home. Proper use of mosquito repellants and common sense measures to reduce exposure to insecticides.

Larvicide – insecticide designed to kill mosquitoes during its larval stage. Larvicides are applied to known mosquito breeding areas to kill larvae.

Adulticide – insecticide designed to kill adult mosquitoes. Mosquito control professionals apply adulticides with ultra low volume (ULV) spray equipment which releases tiny particles of insecticide solution into the air. The amount of pesticide released is typically a few ounces per acre of treated area. Adulticides may be applied from aircraft, vehicles on the ground, or by professional applicators on foot.

Adult mosquito control may be undertaken to combat an outbreak of mosquito-borne disease, or a very heavy nuisance infestation of mosquitoes in a community. Pesticides registered for this use are *adulticides* and are applied either by aircraft or on the ground employing truck-mounted sprayers. State and local agencies commonly use the organophosphate insecticides malathion and naled, and the synthetic pyrethroid insecticides permethrin, resmethrin and sumithrin for adult mosquito control.

Mosquito adulticides are applied as ultra-low volume (ULV) sprays. ULV sprayers dispense very fine aerosol droplets that stay aloft and kill flying mosquitoes on contact. ULV applications involve

small quantities of pesticide active ingredient in relation to the size of the area treated, typically less than three ounces per acre, which minimizes exposure and risks to people and the environment.

3. What can I do to reduce the number of mosquitoes in and around my home?

The most important step is to eliminate potential breeding habitats for mosquitoes. Get rid of any standing water around the home, including water in potted plant dishes, garbage cans, old tires, gutters, ditches, wheelbarrows, bird baths, hollow trees, and wading pools. Any standing water should be drained, including abandoned or unused swimming pools. Mosquitoes can breed in any puddle that lasts more than four days. Make sure windows and screen doors are "bug tight." Replace outdoor lights with yellow "bug" lights. Wear headnets, long sleeve shirts, and long pants if venturing into areas with high mosquito populations, such as salt marshes or wooded areas. Use mosquito repellants when necessary, always following label instructions.

4. Should I take steps to reduce exposure to pesticides during mosquito control spraying?

Generally, there is no need to relocate during mosquito control spraying. The pesticides have been evaluated for this use and found to pose minimal risks to human health and the environment when used according to label directions. For example, EPA has estimated the exposure and risks to both adults and children posed by ULV aerial and ground applications of the insecticides malathion and naled. For all the exposure scenarios considered, exposures ranged from 100 to 10,000 times below an amount of pesticide that might pose a health concern. These estimates assumed several spraying events over a period of weeks, and also assumed that a toddler would ingest some soil and grass in addition to dermal exposure. Other mosquito control pesticides pose similarly low risks. (For more details on health and environmental risk considerations, see the separate EPA fact sheets on the specific mosquito control pesticides).

Although mosquito control pesticides pose low risks, some people may prefer to avoid or further minimize exposure. Some common sense steps to help reduce possible exposure to pesticides include:

* Listen and watch for announcements about spraying in the local media and remain indoors during the application to the immediate area.

* People who suffer from chemical sensitivities or feel spraying may aggravate a preexisting health condition, may consult their physician or local health department and take special measures to avoid exposure.

* Close windows and turn off window-unit air conditioners when spraying is taking place in the immediate area.

* Do not let children play near or behind truck-mounted applicators when they are in use.

5. Where can I get more information?

For more information about mosquito control in your area, contact your state or local health department. The federal Centers for Disease Control and Prevention is also a source of information on disease control, and their Internet web site includes a listing of state health departments. To contact the **Centers for Disease Control and Prevention (CDC):**

Telephone: 970-221-6400
Fax: 970-221-6476
E-mail: dvbid@cdc.gov
web site: http://www.cdc.gov

Information on pesticides used in mosquito control can be obtained from the state agency which regulates pesticides, or from the **National Pesticide Telecommunications Network (NPTN).** The NPTN web site includes links to all state pesticide regulatory agencies.
Toll-free hotline: 1-800-858-7378 (9:30 a.m. to 7:30 p.m. EST) daily except holidays. Callers outside normal hours can leave a voice mail message, and NPTN returns these calls the next business day.
E-mail: nptn@ace.orst.edu
web site: http://ace.orst.edu/info/nptn

Information on mosquito control programs can also be obtained from the **American Mosquito Control Association (AMCA)**
web site: http://www.mosquito.org
This site also lists many county mosquito agencies.

Other Helpful EPA Publications

For Your Information - How to Use Insect Repellents Safely (735-F-93-052R)

For Your Information - Mosquitoes: How to Control Them (735-F-98-003)

For Your Information - Larvicides for Mosquito Control (735-F-00-002)

For Your Information - Naled for Mosquito Control (735-F-00-003)

For Your Information - Malathion for Mosquito Control (735-F-00-001)

For Your Information - Synthetic Pyrethroids for Mosquito Control

For more information regarding the federal pesticide regulatory programs, contact:
EPA Office of Pesticide Programs
Telephone: 703-305-5017
Fax: 703-305-5558
E-mail: opp-web-comments@epa.gov
web site: http://www.epa.gov/pesticides

EPA Regional Offices

Region I - CT, MA, ME, NH, RI, VT
888-372-7341
www.epa.gov/region01

Region II - NJ, NY, PR, VI
212-637-3660
www.epa.gov/region02

Region III - DE, DC, MD, PA, VA, WV
800-438-2474 or **215-814-5000**
www.epa.gov/region03

Region IV - AL, FL, GA, KY, MS, NC, SC, TN
800-241-1754
www.epa.gov/region4

Region V - IL, IN, MI, MN, OH, WI
800-621-8431 (Region V only)
or **312-353-2000**
www.epa.gov/region5

Region VI - AR, LA, NM, OK, TX
800-887-6063 (Region VI only)
or **214-665-6444**
www.epa.gov/region6

Region VII - IA, KS, MO, NE
800-223-0425 or **303-312-6312**
www.epa.gov/region7

Region VIII - CO, MT, ND, SD, UT, WY
800-227-8917 (Region VIII only)
or **303-312-6312**
www.epa.gov/region08

Region IX - AZ, CA, HI, NV, AS, GU
415-744-1500
www.epa.gov/region09

Region X - AK, ID, OR, WA
800-424-4372 (Region X only)
or **206-553-1200**
www.epa.gov/r10earth

Program Name:_____

1. Does your program have a no spray or notification policy for ground ULV spraying?
____Yes ____NO
(If yes answer questions 2, 3 and 4. If no skip to question 5)

2. Is it a formal written policy?
____Yes ____NO

3. Does it include:
___ Notification before spraying
___ Do not spray the resident's property
___ Or some other type (please explain)
_____

4. Are there any general procedures for each type?
___ Yes (If yes, please explain)
_____
_____
___ No

5. What does your program use to justify truck spraying?
___ Light trap data
___ Citizen Complaints
___ Other (If other, please explain)
_____

6. What chemicals does your program currently use in ULV truck spraying applications?

Please list:
_____
_____

7. Does your program use any biological controls?
__ Dragonflies / Damselflies
__ Mosquito Fish
__ Predaceous Copepods
__ Toxorhynchites Larvae
__ Other (please explain)
_____

8. Does your program use mosquito pools for surveillance of diseases?
___ Yes ___ No
If yes are the pools tested by your staff or by a State Lab? ___ Staff ___ State Lab

MOSQUITO CONTROL SPRAY POLICY

The Delaware Mosquito Control Section (Division of Fish and Wildlife, Department of Natural Resources and Environmental Control) utilizes an Integrated Pest Management (IPM) program to control mosquitoes in Delaware.

I. CONTROL METHOD PRACTICES AND PRIORITIES

The Department's (DNREC's) first preference for control is to use environmentally-sound source reduction techniques such as Open Marsh Water Management (OMWM) for saltmarsh mosquito control, managing or manipulating water levels in high-level coastal impoundments so as to disrupt the mosquito's life cycle, or stocking of larvivorous fishes in stormwater basins, backyard ornamental ponds, beaver ponds, etc. Such biological controls are effective in controlling an estimated 95 percent of mosquitoes breeding in areas treated with source reduction. The Department has a long-term program for implementing such approaches and is carrying out this program as time and resources permit. However, source reduction techniques are not suitable for some mosquito producing habitats, and in some cases landowners will not permit the Department to undertake the activities needed for source reduction purposes. In such circumstances, other control measures must then be employed.

The second preference for control is selective application of environmentally-compatible, EPA-registered larvicides (products designed to kill mosquitoes while they are still in the concentrated aquatic life stage) applied to the areas where mosquitoes breed. Aerial larviciding by fixed-wing aircraft or helicopters is usually not practiced directly over residential or developed areas, but ground-applied larvicides are frequently used to treat roadside ditches, flooded fields, used tire piles, abandoned swimming pools, woodland pools, median strip swales, lawn puddles, etc. in urban areas or suburban communities. Aerial larviciding by fixed-winged aircraft or helicopter is primarily used to treat freshwater wetlands, flooded woodlands, or coastal salt marshes or tidal wetlands, and is done only as warranted based upon intensive field surveys of larval occurrence, distribution and abundance. To be effective, larvicides must be applied during a very restricted period in the mosquito's aquatic phase of development. However, unfavorable weather or tidal conditions may prevent effective larvicide applications during this period. Larvicides routinely used in the recent past have included organophosphates such as temephos (Abate); but there is now a tendency to move toward third-generation larvicides, including juvenile growth hormone mimics such as methoprene (Altosid) or bacterial insecticides such as Bti (VectoBac, Aquabac, Teknar). These products may be either liquid or granular formulations. All larvicide products are applied according to federal, EPA-approved label specifications, as required by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

When unfavorable larviciding conditions occur or larviciding has been unsuccessful, it might be necessary to resort to adulticiding (the term used to describe spraying practices to control adult mosquitoes). This type of spraying always occurs via a liquid formulation which ultimately becomes a fog or vapor. This is not to be confused with larviciding, which is often done via a dry/granular formulation. The adulticides used for the control of pestiferous mosquito species (e.g. organophosphates such as naled, or synthetic pyrethroids such as permethrin, resmethrin or sumithrin) are EPA-registered insecticides, which (like the larvicides) have demonstrated minimal human health or environmental risks, and as such can be sprayed over or within populated areas. The EPA has determined that all the mosquito control insecticides applied by the Mosquito Control Section can be used to kill mosquitoes without posing unreasonable risks to human health, wildlife or the environment (but this is not to say that there are no risks at all). Once again, all adulticide products are applied according to federally, EPA-

approved label specifications, as required by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The Department will keep abreast of any EPA announcements that would suggest that a pesticide of choice (larvicide or adulticide) might present greater risks to human health or the environment than previously thought, and certainly comply with any new EPA requirements affecting the use of individual pesticide products.

When adulticides have to be used, our first choice is to apply them aerially within or immediately adjacent to mosquito-breeding areas, immediately after the adult mosquitoes have emerged. This tactic is more effective and less expensive than spraying adulticides over widespread areas after the adults have dispersed. However, before newly-emerged adults migrate to upland zones, the time period available to achieve satisfactory control on or near their breeding habitats is even shorter than for larviciding.

In some cases, however, all of the above controls are inadequate to control mosquito populations prior to their movements into developed areas. In such cases, adulticiding in populated areas might have to be done, particularly if nuisance problems become intolerable or there is the chance of spreading mosquito-borne diseases. These adulticides might be applied aerially (primarily by fixed-wing aircraft) or by ground using truck-mounted sprayers.

This spray policy primarily addresses the issues of insecticide applications in populated areas, with an emphasis on adulticide use whether by aerial or ground applications. The best available scientific information from the EPA and product manufacturers, plus independent research by the University of Delaware and other sources, leads us to conclude that the products we use, and the manner in which we use them, pose no unreasonable risks to the public (human health), wildlife or the environment. The EPA's product-labeling process reflects the permitted use and safety precautions that pesticide applicators must adhere to. The EPA, in order to designate a product's approved use, has to complete a risk assessment, and has to determine that the final end use possesses extremely low human health or environmental risks when applied in accordance with federally-approved label instructions, as required by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

II. ADULTICIDING IN POPULATED AREAS

The decision to spray for mosquitoes in populated areas depends upon two forms of evidence indicating that mosquito populations are unacceptably high. The first form is physical evidence obtained in populated areas from professional analyses of adult mosquito light-trap data (where available) for population abundance and species composition, or upon adult mosquito landing rate counts. Light-trap counts in populated areas exceeding 25 adult females per night of pestiferous species, or landing rate counts averaging three (3) or more adults per minute in populated areas, indicate a nuisance condition substantially lowering the quality-of-life, as well as an enhanced possibility for mosquito-borne disease transmission. Except when there are additional reasons to believe that some mosquito species may be presenting a significant public health risk, no spraying will be conducted unless physical or complaint evidence suggests that spraying is warranted.

The second form of evidence is public complaints in populated areas, resulting in requests for spraying coming from either individuals, civic or homeowners associations, or local city or town officials within incorporated municipalities. To the extent practicable the Section will investigate in the field the need for a spray response based on the physical evidence previously described, collected in manner as can be practicably obtained in the field in consideration of mosquito species-specific diurnal/nocturnal activity patterns, sampling limitations, and staff or equipment logistical constraints. The Mosquito Control Section will decide whether spraying is

warranted on the basis of physical evidence alone; or by the merit, as determined by the Section, of a municipal request; or by the number and merit, as determined by the Section, of citizen complaints directly received by the Section. **[In regard to public requests for adulticide spraying coming from incorporated areas, the Section requires that citizen requests for spraying during an infestation be coordinated and conveyed to the Section by phone through a designated municipal official.]**

III. PROTOCOLS FOR ADULTICIDING INCORPORATED MUNICIPALITIES

1. Mosquito Control Municipality Spray Endorsement

On an annual basis, each incorporated municipality (city or town) desiring aerial adulticiding or aerial larviciding will prepare and sign a waiver on official municipal letterhead permitting spray application of insecticides by low-flying aircraft for treatments to be done by the Delaware Mosquito Control Section or its contractors, in order to comply with Federal Aviation Administration (FAA) regulations.

Before the start of the pest season (by early or mid-March), the municipality will also acknowledge and agree to through a signed endorsement the Mosquito Control Spray Policy's provisions, in order to allow and request the Mosquito Control Section to spray as warranted either all or portions of areas within the municipality's jurisdiction in accordance with this Spray Policy. Return of the signed endorsement requesting spraying will be needed for the Section to spray by fixed-wing aircraft, helicopter, or truck-mounted sprayer or fogger any adulticides or larvicides within a municipality's borders, with exception of aerial spraying of larvicides over coastal tidal wetlands, and with exception of ground application of larvicides to tidal or non-tidal wetlands or other aquatic breeding sites by truck-mounted sprayers or hand application methods. [In regard to these last two situations, approval from municipalities is *not* necessary for the Section to aerially treat coastal tidal wetlands with larvicides, nor to make ground applications of larvicides in tidal or non-tidal wetlands or other aquatic breeding sites.] Without receipt of this signed endorsement, the Section will assume that the municipality does not want any aerial adulticiding or non-tidal wetland aerial larviciding, nor any truck-mounted spraying of adulticides, within their jurisdiction during the current pest season (mid-March through mid-November). If a municipality does not sign and return the endorsement before start of the pest season, it must be kept in mind that any change of thought resulting in a municipality to then request spraying later in the season cannot be honored until the endorsement is signed and returned to the Section, which in many cases might slow down or even prohibit the Section's ability to provide timely treatment, even in response to severe nuisance problems or potential disease outbreaks.

2. Adulticide No-Spray Requests and No-Spray Zones

The Mosquito Control Section will not spray those municipality areas delineated by the municipality, and agreed to by the Section, to be zones where: 1) no aerial adulticide can be applied; or 2) areas where no ground adulticide can be applied; or 3) areas where neither method of adulticiding can be done. *Residents/property owners within an incorporated municipality desiring not to be included in the aerial or ground adulticide program must make such requests known by contacting their local municipal government officials.* The decision to request or authorize a No-spray zone within a municipality, and the consequences for doing such, are entirely the responsibility of a municipality's officials. It is anticipated that such No-spray zones will not be sought by municipalities for non-residents or non-property owners (i.e. not applicable to casual visitors or tourists). The municipality, after accounting for factors given in Section 3 below (for sizes of No-spray zones), will prepare maps of No-spray zones that were requested by their citizens and approved by the municipality, and submit these maps to the Mosquito Control

Section for review and concurrence. Please note that it is important that the locations and sizes of each No-spray zone within a municipality be identified each and every year, as there will be no automatic carryover of No-spray zone designations from previous years. The Section will review the submitted maps and inform the municipality in writing (by U.S. Mail or e-mail) of its concurrence. If concurrence cannot be given by the Section for the proposed No-Spray zones because of technical or logistical problems, the Section will then meet with municipal officials to resolve these problems. If a municipality wishes to modify the No-spray zone designations after the pest season has started (i.e. after mid-March), the municipality may request such modification from the Section, but should understand that the Section will need at least two weeks advance notice in order to comply with the requested modification.

With exception of a declared public health emergency by appropriate State-level agencies, it must be understood that within a municipality the decision to adulticide for mosquito control purposes or not to spray is totally up to municipal officials, who have to weigh several factors in making this decision, to then possibly be followed by requesting the Mosquito Control Section's treatment services. These officials have to consider the impacts of intolerably high mosquito populations on quality-of-life factors and local economies, along with the possibility of mosquito-borne disease transmission, weighed against very negligible risks to human health or the environment when using EPA-registered adulticides in manner prescribed by the EPA, plus perhaps aircraft noise issues occasionally associated with aerial applications. If a resident or visitor to an incorporated city or town has a problem with this municipal decision, their complaint or grievance should be taken up with the municipality, not with the Mosquito Control Section. If a resident or visitor's complaint or problem involves aircraft noise or other operational issues for how spraying was done, exclusive of concerns or issues dealing with pesticide exposure, the municipality should, in consultation with the Mosquito Control Section, attempt to directly address these issues with the resident or visitor making such complaint. If the complaint or problem concerns pesticide exposure, which in many cases is quite unavoidable in responding to a municipality's request for adulticiding over or within populated areas, the Mosquito Control Section will assist a municipality in technically addressing a complaint or issue raised by a resident or visitor. However, it must be kept in mind that the Section applied the adulticide at the municipality's request, in conjunction with the Section also independently investigating to the extent practicable that the adulticiding was warranted.

3. Sizes of No-Spray zones

Because of technical constraints, a No-spray zone for aerial adulticiding must be a minimum of 6 acres in size(approximately 500 ft. x 500 ft.), and a No-spray zone for ground spraying must be a minimum of 2 acres in size (approximately 300 ft. x 300 ft.). Operationally, in almost all cases it will probably **not** be necessary for the No-spray zone be much larger than these minimums (in order to avoid treating the residence where no spraying has been requested), but the final determination of the size of the No-spray zone will be made by the Section on a case-by-case basis.

It must also be recognized by the local municipalities that certain configurations or densities of No-spray zones might also prohibit adulticide spraying to an extent greater than the mere summation of individual No-spray zones. It must also be kept in mind that in many locations the creation of a No-spray zone for an individual residence will preclude adulticide treatment for many neighbors or nearby residences who desire pest relief -- this situation is a dilemma that the local municipality must resolve.

4. **Requests for Adulticide Spraying within Municipalities**

A city or town each year signing and returning an annual endorsement form does **not** mean that a municipality then automatically receives **all** of our mosquito control services whenever needed without any further actions on the city's or town's part. Converse to this and as a specific exception (and exclusive of a public health emergency that Mosquito Control might recognize), **each and every time** that a municipality wants Mosquito Control to undertake any **adulticide** spraying (to control adult mosquitoes), done by Mosquito Control either via ground-based or aerial applications within or over areas under a municipality's jurisdiction, **then the municipality's designated Mosquito Control contact person** (as indicated by the city or town on the endorsement form), or some other appropriate city or town official, **must first contact the Mosquito Control Section and request such adulticiding.** Please note that there can be occasions when Mosquito Control might recommend to a city or town that such type of spraying be undertaken (based on technical information that our program collects) and whereby we advise that the municipality then officially requests that we take such spray actions, but in many instances it will be more a matter of the city or town first contacting us on an **event-by-event** basis to request that Mosquito Control performs some adulticide spraying (which could be determined by a city or town as being necessary or desirable for Mosquito Control to undertake via a municipality hearing from its citizens or constituents about intolerable local mosquito infestations, or by other means or devices that a city or town might have at its disposal). For cities or towns in New Castle County and northwestern Kent County (for the latter to include all municipalities north of Dover to the west of Rt. 13, plus Smyrna too), the number to call is our Glasgow office at 302-836-2555; for cities or towns in the remainder of Kent County and all of Sussex County, the number to call is our Milford office at 302-422-1512.

5. Advance Notification of Spray

When there is a good probability that adulticiding operations are imminent within a municipality, to the extent practicable for sake of public notification the Mosquito Control Section will, for each adulticiding event (whether done by air or truck), do the following:

1) contact in advance by telephone an appropriate government official and provide by telefax a spraying announcement to each affected municipality;

2) place a phone spraying announcement on a Mosquito Control Section recorder that citizens can call toll-free at 1-800-338-8181 to find out about the status of spraying;

3) on a statewide basis, contact over 12 local radio stations by telefax and provide a spraying announcement, which the radio stations may or may not choose to broadcast;

4) post a similar spraying announcement on the Mosquito Control Section's (Division of Fish and Wildlife's) DNREC webpage, which the public can access via the Internet at http://www.fw.delaware.gov/Services/MosquitoSection.htm (go to "Mosquito Spraying Announcements" once you have accessed this webpage).

5) for anybody who wants to personally receive via e-mail up-to-date spraying announcements, they can subscribe to a Mosquito Control listserver that will automatically disseminate such announcements to them via the Internet (simultaneously done in conjunction with posting these spraying announcements on Mosquito Control's DNREC webpage)-- the sign-up for this

listserver can be accomplished by accessing the Mosquito Control webpage address given above in item #4;

6) finally, immediately prior to aerial applications of adulticides, the treatment aircraft will briefly circle over pertinent areas within a municipality, to provide final notification or signal in the field of intention to spray.

Any additional notification of intent to spray is up to the participating municipalities to perform or offer, but it is probable that giving additional public notice going beyond what the Mosquito Control Section presently performs would not be very feasible or practicable to do.

To the extent feasible and practicable, with exceptions for health emergencies or when contending with unsettled weather conditions for spraying, such advance notification will be issued by the Mosquito Control Section at least four (4) hours before any adulticide spraying begins, and be done for every adulticiding effort within a municipality's jurisdiction.

The advance notification procedure for spraying described above will now also be followed for every *aerial* larviciding effort within a municipality's jurisdiction (in the past, such notice was routinely provided for spring woodland control aerial larviciding and other aerial treatments of freshwater wetlands, but was not done for aerial larviciding of coastal marshes). While aerial larviciding operations in treating wetland breeding sites usually do not involve spraying directly over people, the unfortunate terrorism events of September 11, 2001 have now greatly increased the public's concern and anxiety about possible bioterrorism incidents, which could occur (at least in theory) via pesticide spray delivery systems, so it is now prudent to ensure that municipal officials are fully aware in advance of any-and-all adulticiding (whether done by air or truck) or aerial larviciding within their jurisdictions. What will not be publicly announced will be truck-based spraying of larvicides (e.g. along roadside ditches) or hand-applied larviciding done on foot (e.g. when treating localized breeding sites in small pocket marshes or in residential areas), since these types of activities are: 1) sometimes numerous and scattered; 2) are often not determined to be necessary until actually on-site; and 3) because of their carefully targeted applications to localized surface water (as opposed to the widespread spraying of adulticide aerosols over uplands or marshes by aircraft or truck, or the relatively widespread aerial spraying of larvicides over wetlands), such applications hardly generate any public awareness, concern or comment.

For sake of good communications, and to help other agencies respond to possible public inquiries about mosquito control spraying activities, advance notifications of spraying are also provided by the Mosquito Control Section via telefax or e-mail to the Delaware Emergency Management Agency (DEMA), to each county's 911 Emergency Call Center, and to the Delaware Department of Agriculture's (DDA) Pesticide Compliance Section and to the DDA's State Apiarist.

Additionally, by a working agreement adopted in 2001 among the Mosquito Control Section, the DDA's State Apiarist, and the Delaware Beekeeping Association, for all aerial adulticide spray announcements the Mosquito Control Section now indicates via coded grid-block numbers (for a special map of Delaware) where aerial adulticide spraying activities are intended to occur. By the tri-party working agreement, it is incumbent upon commercial beekeepers to assume responsibility for their keeping up-to-date and for their being aware about locations where aerial adulticiding is soon intended, achieved by the beekeepers taking advantage of the various spray announcement devices mentioned above (i.e. toll-free phone calls, radio announcements, webpage postings, listserver e-mails). If a commercial beekeeper has a problem with where some spraying will soon occur, the beekeeper should then inform the Mosquito Control Section in timely manner about such concerns, so that appropriate spray measures can be taken by Mosquito Control to avoid or minimize any adverse impacts to

beekeeping operations. Since commercial beekeepers frequently move their bee colonies around in addressing crop pollination needs, and since the need for mosquito control spraying can be quite geographically variable and occur with relatively short notice, it is important that good two-way communications be maintained between Mosquito Control and commercial beekeepers, which adherence to the working agreement's protocols is intended to provide. The State Apiarist distributes to each of Delaware's registered beekeepers a copy of the working agreement and the coded grid map.

6. Time of Spraying

To the extent feasible and practicable, adulticide spraying will be conducted at times which minimize direct human exposure (preferably early morning or late evening for aerial applications). During the summer peak "tourist season" from the Friday evening immediately before the Memorial Day weekend through the Monday evening of Labor Day weekend, aerial adulticide applications in the "coastal resort strip" from Lewes to Fenwick Island may be made on weekdays in the morning from 5:30 to 8:30 a.m. and in the evenings from 6:00 to 9:00 p.m., excluding the weekend that is defined here as Friday evenings through Monday mornings (and through Monday evenings on holiday Mondays). The "coastal resort strip" itself may be viewed as extending landward of the Atlantic Ocean coastline from Lewes to Fenwick Island a distance of up to about 5 miles inland, as well as about 2 miles landward of the primary bayshores composing the Inland Bays. Exceptions to not aerially adulticiding the coastal resort strip between Friday evening and Monday morning can occur at special request (in writing) from a municipality, or in event that inclement weather or other circumstances prevent adulticiding at other times, whereby only the Friday evening to Monday morning weekend period is left for timely spray application. Aerial adulticide applications will only be made when weather conditions comply with product-label spraying requirements (e.g. clear visibility and winds no more than 10 mph). Outside the coastal resort strip area, the weekend exclusion for adulticide spraying will not apply, but the daily time slots for spraying will still apply. An exception to the desired early morning and evening times for aerial spraying can occur when unusual weather conditions (e.g. fog, excessive wind, temperature inversions) preclude applications at the desired times, and yet the mosquito situation is so bad that spraying must still be performed that day, in which case spraying would also be permissible in the day between early morning and late evening. Ground applications of adulticides statewide may generally be done from early evening through early morning on weekdays or weekends, except that municipalities within the coastal resort strip from Lewes to Fenwick Island during the summer peak "tourist season" will generally not receive ground adulticide applications on the weekends (defined as above); municipalities within the coastal resort strip still might be ground-sprayed on weekends at special request (in writing) of a municipality, or if inclement weather or other circumstances prevent timely ground applications at other times. Ground applications will only be done when weather conditions comply with product-label spraying requirements.

7. Adulticides Used

The Mosquito Control Section may aerially apply by twin-engine aircraft at application rates up to those indicated below one or more of the following adulticides, with the choice of which product to use per spray event dependent upon the problem species to treat and other technical factors or local considerations:

1) Dibrom Concentrate (naled) applied at 0.10 lbs. AI/A, applied in ULV concentrated formulation of 1.0 oz./A, or

2) Trumpet EC (naled) applied at 0.10 lbs. AI/A, applied in ULV concentrated formulation of 1.2 oz./A, or

3) Scourge 18%+54% MF (resmethrin + PBO) applied at 0.007 lbs. resmethrin AI/A + 0.021 lbs. PBO AI/A, mixed with mineral oil, applied at a total volume of 3 oz./A (O.6 oz. Scourge 18-54/A plus 2.4 oz. mineral oil/A), or

4) Anvil 10+10 (sumithrin + PBO) applied at 0.0036 lbs. AI/A, applied in ULV concentrated formulation of 0.62 oz./A, or

5) Permanone 31-66 (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation, or

6) Biomist 31+66 ULV (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation, or

7) Kontrol 31-67 Concentrate (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation, or

8) Evoluer 30-30 ULV (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation, or

9) Aqualuer 20-20 (permethrin + PBO) applied at 0.0035 lbs. AI/A applied in ULV concentrated formulation.

The following adulticides may be ground applied at application rates up to those indicated by truck-mounted Beecomist ULV (Ultra Low Volume) or London Fog ULV ground foggers:

1) Scourge 18%+54% MF (resmethrin + PBO) applied at a rate up to 0.007 lbs. resmethrin AI/A + 0.021 lbs. PBO AI/A, mixed with mineral oil, applied at a total volume of 3 oz./A (0.6 oz. Scourge 18-54/A plus 2.4 oz. mineral oil/A), or

2) Anvil 10+10 (sumithrin + PBO) applied at 0.0036 lbs. AI/A, mixed with mineral oil, applied at a total volume of 1.24 oz./A (0.62 oz./A Anvil 10+10 plus 0.62 oz. mineral oil/A), or

3) Permanone 31-66 (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation, or

4) Biomist 31+66 ULV (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation, or

5) Kontrol 31-67 Concentrate (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation, or

6) Evoluer 30-30 ULV (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation, or

7) Aqualuer 20-20 (permethrin + PBO) applied at 0.0035 lbs. AI/A, applied in ULV concentrated formulation.

The Mosquito Control Section will provide a copy of each adulticide's product label and its accompanying Material Safety Data Sheet (MSDS) to each municipality for their information.

8. Larvicides Used

The Mosquito Control Section may apply at application rates up to those indicated one or more of the following larvicides aerially by twin-engine aircraft or helicopter, or from the ground using truck-mounted sprayers or hand application methods, with the choice of which product to use per spray event dependent upon the problem species to treat and other technical factors or local considerations:

1) Abate 4E (temephos) applied at 0.048 lbs. AI/A, applied at 1.5 oz. Abate 4E/A mixed with water to achieve a final application volume of 64 oz./A, or

2) Abate 5BG (temephos) applied at 0.1 lbs. AI/A, applied in granular formulation at 2 lbs./A, or

3) Abate 2BG (temephos) applied at 0.1 lbs. AI/A, applied in granular formulation at 5 lbs./A, or

4) VectoBac 12AS (Bti) applied at 32 oz./A, or

5) VectoBac CG or G (Bti) applied in granular formulation at 10 lbs./A, or

6) Aquabac XT (Bti) applied at 32 oz./A, or

7) Aquabac 200G (Bti) applied in granular formulation at 10 lbs./A, or

8) Teknar HPD (Bti) applied at 32 oz./A, or

9) Teknar G (Bti) applied in granular formulation at 10 lbs./A, or

10) Altosid Liquid Larvicide (5% methoprene) applied at 0.013 lbs. AI/A, applied at 4 oz./A mixed with water to achieve a final application volume of 32 oz./A, or

11) Altosid Liquid Concentrate (20% methoprene) applied at 0.013 lbs. AI/A, applied at 1 oz./A mixed with water to achieve a final application volume of 32 oz./A, or

12) Altosid Pellets (methoprene) applied at 10 lbs./A, or

13) Altosid SBG (methoprene) applied in granular formulation at 10 lbs./A, or

14) Altosid Briquets (methoprene) applied at one briquet/100 sq. ft., or

15) Altosid XR Extended Residual Briquets (methoprene) applied at one briquet/200 sq. ft., or

16) VectoLex CG (Bacillus sphaericus) applied in granular formulation at 20 lbs./A, or

17) Agnique MMF (nonionic surfactant) applied at 3 oz/1000 sq. ft., or

18) Arosurf (nonionic surfactant) applied at 3 oz/1000 sq. ft.

The Mosquito Control Section will provide a copy of each larvicide's product label and its accompanying Material Safety Data Sheet (MSDS) to each municipality for their information.

9. Public Health Emergencies

In the event of an Eastern Equine Encephalitis (EEE), St. Louis Encephalitis (SLE), or West Nile Encephalitis (WNE) public health emergency, jointly recognized by DNREC and the Delaware Division of Public Health, aerial or ground adulticiding might be carried out over municipalities that have not signed the Spray Policy endorsement agreeing to permit such activities, as well as spraying also possibly occurring in designated No-spray zones, ceasing when the public health emergency is terminated. In event of a public health emergency, general public health considerations to prevent or lessen serious disease problems must take precedent over individual desires to avoid a short-term exposure to an insecticide that is registered by the EPA for application over populated areas, with knowledge that such exposures will of course take place but which are of minimum risk to human health and safety. The Section will try to continue to observe to the extent feasible and practicable its policies on advance notification, timing of spraying, and type of insecticides used, but public health concerns during emergencies may necessitate deviations from these protocols, such as for application timing, for treating No-spray zones, etc.

IV. PROTOCOLS FOR ADULTICIDING UNINCORPORATED AREAS

The spraying of adulticides by aerial or ground application in unincorporated areas does not require a signed Mosquito Control Spray Policy endorsement such as is needed prior to spraying incorporated municipalities. Because of insurmountable practical and logistical problems in communicating with individual citizens or civic associations in unincorporated areas, the Mosquito Control Section must assume that timely and safe adulticiding is allowable and desired whenever pest populations become excessive or mosquito-borne disease potentially threatens. The Section will determine when and where adulticiding is necessary, based on physical evidence and in conjunction with complaints from individual citizens or civic associations. Similarly, the Section's ability to use larvicides, whether applied aerially or by ground, will not require any signed endorsements for when spraying is done in unincorporated areas.

Requests for no spraying of ground or aerially-applied adulticides in unincorporated areas can be made by individual residents or property owners by directly contacting the Mosquito Control Section, to request a form for applying for No-spray zone consideration, which after completion should then be returned to the Mosquito Control Section at the address indicated on the form (note: to request the application form, contact the Mosquito Control Section at 302-739-9917; or write to Delaware Mosquito Control Section, Division of Fish and Wildlife, DNREC, 89 Kings Highway, Dover, DE. 19901; or you can download a copy of the form over the Internet, by accessing http://www.fw.delaware.gov/Services/MosquitoSection.htm, and then go to "Request a No-spray Zone application"). All such requests must be made prior to March 1 for each pest season and must be made in writing using the approved form, which will request information such as name, address, and telephone number of the resident or property owner requesting no spraying, a map indicating the location of the property not to be adulticided, and the reason(s) for requesting the No-spray zone. The names, addresses and phone numbers of all

residents or property owners bordering a property where no spraying is requested, or who would be located within the requested No-spray zone block, must also be submitted by a person requesting a No-spray zone. This will assist the Mosquito Control Section in evaluating the No-spray zone request and in providing explanations to people who might then not receive pest relief services, resulting from their neighbor being granted a No-spray zone designation. However, if the entire requested No-spray zone block all fits inside the property of the person requesting such designation, with the borders of the requested No-spray zone coming no closer than 300 feet to any neighbor's property boundaries, then submitting information about neighboring residents or property owners will not be required. Individuals must indicate whether they are requesting no aerially-applied adulticides, no ground-applied adulticides, or both. This request for no spraying must be submitted each and every year using the approved form, as there will be no automatic carryover of No-spray zone requests from year to year. If an individual citizen or civic association in an unincorporated area wishes to request a No-spray zone after the pest season has started (i.e. after mid-March), such requests may be submitted in writing to the Section similar to requests made prior to mid-March. However, due to the logistical problems in changing operational spraying procedures and advising contractors of revisions, the requester should understand that the Section will need at least two weeks advance notice in order to consider and review the request and to initiate procedural changes (if any).

Based upon the written requests for no spraying of adulticides, the Section will determine the need for and boundaries of No-spray zones and will notify the individual of the Section's decision. When possible, the Section prefers that individual requests for no spraying in areas or neighborhoods that have civic associations be coordinated and conveyed in writing to the Section by the civic associations prior to mid-March; however, individual requests can still be presented to the Section.

The application of adulticides in unincorporated areas will be similar to what is done in incorporated municipalities regarding times of spraying, insecticides used, and public health emergencies. However, in regards to providing advance notification of each spraying event, and because of insurmountable logistical problems, telephone calls or other personal contacts by the Section to individual citizens or civic associations will *not* be made. Nonetheless, concerned citizens can still inquire about the Section's intentions to spray by contacting, on a daily basis, the toll-free phone recording at 1-800-338-8181 or the Section's webpage posting at http://www.fw.delaware.gov/Services/MosquitoSection.htm (and go to "Mosquito Spraying Announcements" on the webpage), or they can subscribe to the Section's listserver to automatically receive such spray announcements via the Internet, and they can also be aware of pending spray operations by listening to any spray announcements that may be broadcast by local radio stations.

V. RESOLVING CONFLICTS IN UNINCORPORATED AREAS BETWEEN PERSONS REQUESTING NO SPRAYING VS. PERSONS WANTING PEST RELIEF VIA ADULTICIDING

Whenever possible, persons living in unincorporated areas who do not desire adulticiding will try to be accommodated by the Mosquito Control Section. However, conflicts sometimes arise when one or more nearby neighbors demand adulticiding for pest relief. Such conflict can arise either during the consideration or designation process for a No-spray zone or after a No-spray zone has been designated. When such conflict arises, the Section will attempt to resolve the disputes on a case-by-case basis, resulting in either continuation or resumption of adulticiding measures, modification of adulticiding measures, or stopping or continued cessation of adulticiding measures. Value judgments of public health, safety, comfort and quality-of-life must be weighed against the health or other concerns of an individual requesting no spraying. Individuals with special medical problems possibly attributed to pesticide exposure can obtain a

physician's written opinion acknowledging pesticide sensitivity, and such people will be given special consideration by the Section to the extent feasible and practicable. The Section will try to resolve all conflicts in a manner acceptable to all parties, but public health concerns (e.g. arbovirus encephalitis outbreaks) must take precedence over other considerations. For most individuals having health-related concerns involving adulticide exposures, such people can satisfactorily minimize their concerns by paying attention to the advance spray notification process, followed by their taking common-sense measures to minimize or avoid exposure (e.g. temporarily leave the spraying area, temporarily moving inside, temporarily closing windows and doors, etc.). However, please note that given the safety of the types of EPA-registered adulticides or larvicides that the Section uses, and how these products are then applied with very minimal human health risks, which for a vast majority of people no special precautions need to be taken to avoid exposure to the Section's operational spraying.

VI. POLICY APPLICABILITY – TYPES OF SPRAY APPLICATIONS

This policy's requirements to request participation of incorporated cities or towns, and to give advance notice of intention to spray in incorporated cities or towns, is applicable to aerial applications of adulticides, as well as for ground application of adulticides when delivered by truck-mounted sprayers. Participatory consent by cities or towns is also needed for aerial applications of larvicides during the spring woodland control program or for aerial larviciding of other freshwater wetlands; but such participatory consent from municipalities is not needed for aerial larviciding over coastal tidal wetlands, nor for the ground application of larvicides by truck-mounted sprayers or hand application methods. However, advance spraying notice of all aerial larviciding within municipalities will be given. This policy's requirements for the Mosquito Control Section to give advance notice to cities or towns of intention to spray is not applicable to ground applications of larvicides when delivered by truck-mounted sprayers or on-foot by back-pack sprayer, hand-held sprayer, or hand toss. [It must be noted that if a municipality desires only on-foot applications of insecticides that are done by hand, and does not agree to aerial applications of insecticides nor to adulticide applications by truck-mounted sprayers, in many cases and locations it will then not be possible to provide satisfactory nuisance control or disease prevention.]

The spray policy is also applicable to insecticide applications that are made for mosquito control in unincorporated areas, in regard to many needs, matters or practices that are similar to what occurs in cities or towns; as well as providing some protocols that are specific or unique for adulticiding in unincorporated areas, where municipal government interactions are not possible nor applicable.

Finally, requirements to follow this spray policy can be waived by DNREC during a declared public health emergency (see Section III-8).

VII. GENERAL EMERGENCY WAIVERS

The Department, for exceptional circumstances or during emergencies, may modify this policy on a case-by-case basis.

VIII. POLICY ADOPTION

This "Mosquito Control Spray Policy" is adopted as Delaware Department of Natural Resources and Environmental Control management policy, and supersedes any previous written or unwritten policies.

First formulated and adopted in February, 1990.

Latest revision = January 10, 2008.

ADULT MOSQUITO CONTROL POLICY

POLICY STATEMENT

Preamble

Whereas the City of Winnipeg is committed to utilizing environmentally friendly approaches in the services that it delivers including a reduction in the use of chemical pesticides, The Insect Control Branch's long term strategy is to reduce the necessity for controlling adult nuisance mosquitoes.

The Mosquito Control Program will be delivered based on the principles of an Integrated Pest Management Strategy (IPM). IPM is a decision making process that uses a combination of techniques to suppress pests and that must include but is not limited to the following elements:

- planning and managing ecosystems to prevent organisms from becoming pests;
- identifying potential pest problems;
- monitoring populations of pests and beneficial organisms, pest damage and environmental conditions;
- using injury thresholds in making treatment decisions;
- reducing pest populations to acceptable levels using strategies that may include a combination of biological, physical, cultural, mechanical, behavioural and chemical controls; and
- evaluating the effectiveness of those treatments.

The Insect Control Branch IPM strategy is based on the following components:

- Surveillance;
- Larviciding;
- Source Reduction;
- Public Awareness; and
- Adulticiding.

Beginning in 2005, a biological based larviciding program will be phased-in over three years in order to reduce the City's use of chemical pesticides and reduce the City's reliance on adult mosquito control.

Pre-emptive Barrier Treatments will also be utilized to further reduce the City's need to implement a fogging program. Barrier treatments involve the application of environmentally-sensitive products onto localized areas of long grass, etc in order to kill adult mosquitoes in their resting place during the day.

1) Consideration to initiate or stop adulticiding will be based on the **Adulticiding Factor Analysis (AFA) Guidelines.**

Adulticiding Factor Analysis (AFA) Guidelines

Definition - AFA: The analysis and overall judgment of multiple factors and conditions that are considered when undertaking a decision as to whether to initiate or stop an adult nuisance mosquito control program. The adult nuisance mosquito control program may include pre-emptive barrier spraying or fogging in local areas or throughout the city. The City Entomologist will implement adult mosquito control activities based on the defined categories of a Low – Medium – High AFA.

AFA LOW – The AFA will be considered to be low through an analysis and judgment of the following factors:

- current moisture conditions in the soil and the probability of new significant rainfall in the next 7 days are minimal
- the current percent of nuisance adult mosquitoes from the New Jersey Light Traps is low
- the current stage of adult mosquito generation is decreasing, eg. adult nuisance mosquitoes are starting to die off as they are near the end of their lifecycle
- the "current degree day model" combined with other environmental conditions are not conducive for continued adult mosquito development
- the larval development sites do not indicate the continued increase in production of new adult mosquitoes
- effectiveness of larviciding indicates that the outlook for adult mosquito emergence is expected to not occur for more than one week

When the AFA is low pre-emptive barrier spraying or ULV adulticiding (fogging) will not be considered.

AFA MEDIUM – The AFA will be considered to be medium through an analysis and judgment of the following factors:

- low moisture levels in the soil are increasing and there is a forecasted probability of new significant rainfall expected in the next 7 days (>2.2 cms), resulting in new additional water bodies being added to the current inventory of larval development sites
- the current percent of nuisance adult mosquitoes from the New Jersey Light Traps will potentially increase
- the current status and stage of adult mosquito generation at large is increasing, eg. adult mosquitoes are at an early part of the lifecycle and will be present for some time and are human biters.
- The "current degree day model" combined with other environmental conditions are becoming conducive for continued adult mosquito development
- the larval development sites indicate the continued increase in production of new adult mosquitoes even with enhanced effective larviciding
- the outlook for adult mosquito emergence is expected to continue for more than one week

When the AFA is medium some pre-emptive barrier spraying may be considered in areas where control can reduce adult mosquito numbers before they become a high nuisance issue. At this level no ULV adulticiding (fogging) will be considered.

AFA HIGH – The AFA will be considered to be high through an analysis and judgment of the following factors:

- the medium moisture levels in the soil are becoming saturated and the forecasted probability of new continued significant rainfall is expected over the next 7 days (>2.2 cms) resulting in new additional water bodies being added to the current inventory of larval development sites
- the current percent of nuisance adult mosquitoes from the New Jersey Light Traps is high and are increasing at a rate where the new generations of nuisance adult mosquito are all at a level in the early part of the lifecycle and will be present for some time
- the "current degree day model" combined with other environmental conditions are conducive for the continued adult mosquito development
- the larval development sites indicate the continued re-emergence of new adult mosquitoes
- the outlook for adult mosquito emergence is expected to continue for more than one week
- enhanced larviciding efforts continue to be required

When the AFA is high, and pre-emptive barrier spraying to reduce adult mosquitoes has been carried out in local areas, ULV adulticiding (fogging) will be considered in specific areas or throughout the city.

2) The Pesticide Use Permit issued by Manitoba Conservation will be adhered to with respect to its restriction, conditions and terms set forth in the permit.

3) Mosquito adulticiding will be carried out only within the present boundaries of the City of Winnipeg by mounted Ultra Low Volume (ULV) sprayers with the corresponding Global Positioning System (GPS), Geographic Information System (GIS) and computer hardware available.

4) Pre-emptive barrier treatments may be considered in areas where surveillance and adult mosquito monitoring have determined that public property may require localized treatment with an adulticiding pesticide product. This will allow for a reduction in nuisance or vector mosquitoes in a specific area before considering a fogging program within the City of Winnipeg.

5) Adulticiding will be carried out along public streets and lanes, and major parks, golf courses, and cemeteries owned and operated by the City of Winnipeg, as determined necessary by the City Entomologist. Furthermore, the City Entomologist may exclude specific areas of the City from an adulticiding program.

6) The Community Services Department Insect Control Branch crews are not allowed to enter onto private property to carry out any mosquito adulticiding. Adulticiding will only occur in city owned areas identified for adult mosquito control by the City Entomologist.

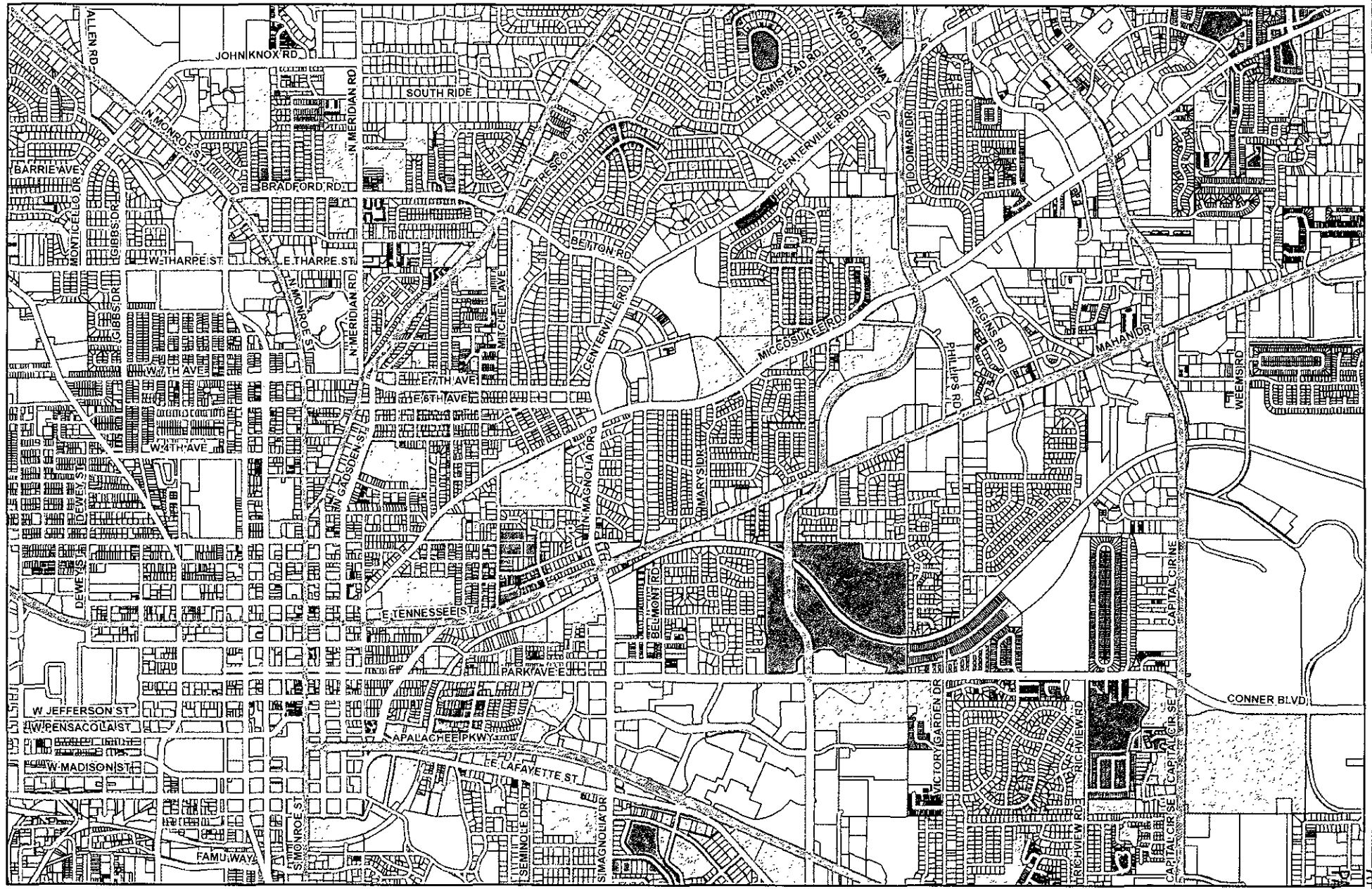
7) Adulticiding will be conducted using only Pest Management Regulatory Agency (PMRA) approved pesticides, and utilizing PMRA's label defined application rates. Factors that shall be considered in selecting a product are: environmental acceptability, those most effective, and those that can be applied within the limitations of available adulticiding equipment.

8) The Community Services Department Insect Control Branch will pursue those aspects of product research and development in order to ensure proper storage, handling and application of the pesticides. All adulticiding pesticides will undergo a pre-use, during use and post use concentration analysis of active ingredient. The emphasis of this research will be directed towards identifying safer insecticides; the economics of use; and methodologies with improved information on insecticides and their efficacy in the environment. Research will also examine alternatives to insecticide use and methods of operation that reduce risks to human health and non-target organisms.

9) City residents can register with the Insect Control Branch as an Anti Pesticide Registrant (APR) in order to exempt their property during residential adulticiding. The APR's property is based on the centroid of the civic property plan to a maximum

buffer of 100 meters. Adulticiding will not be carried out within the buffer, except as ordered during a declared health emergency by the Provincial Chief Medical Health Officer. All notices for exemption must be in written form and received at least 48 hours prior to adulticiding by the Community Services Department Insect Control Branch.

10) Residents who contact the Community Services Department Insect Control Branch will be advised whether or not they are within a defined APR buffer zone, however the specific addresses of the APR's will not be provided, as per the Freedom of Information and Protection of Privacy Act.



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Map created on Feb 1, 2010
by Trida McClanahan
Tallahassee-Leon County GIS
(850) 606-1539
Web: http://www.tlcgis.org

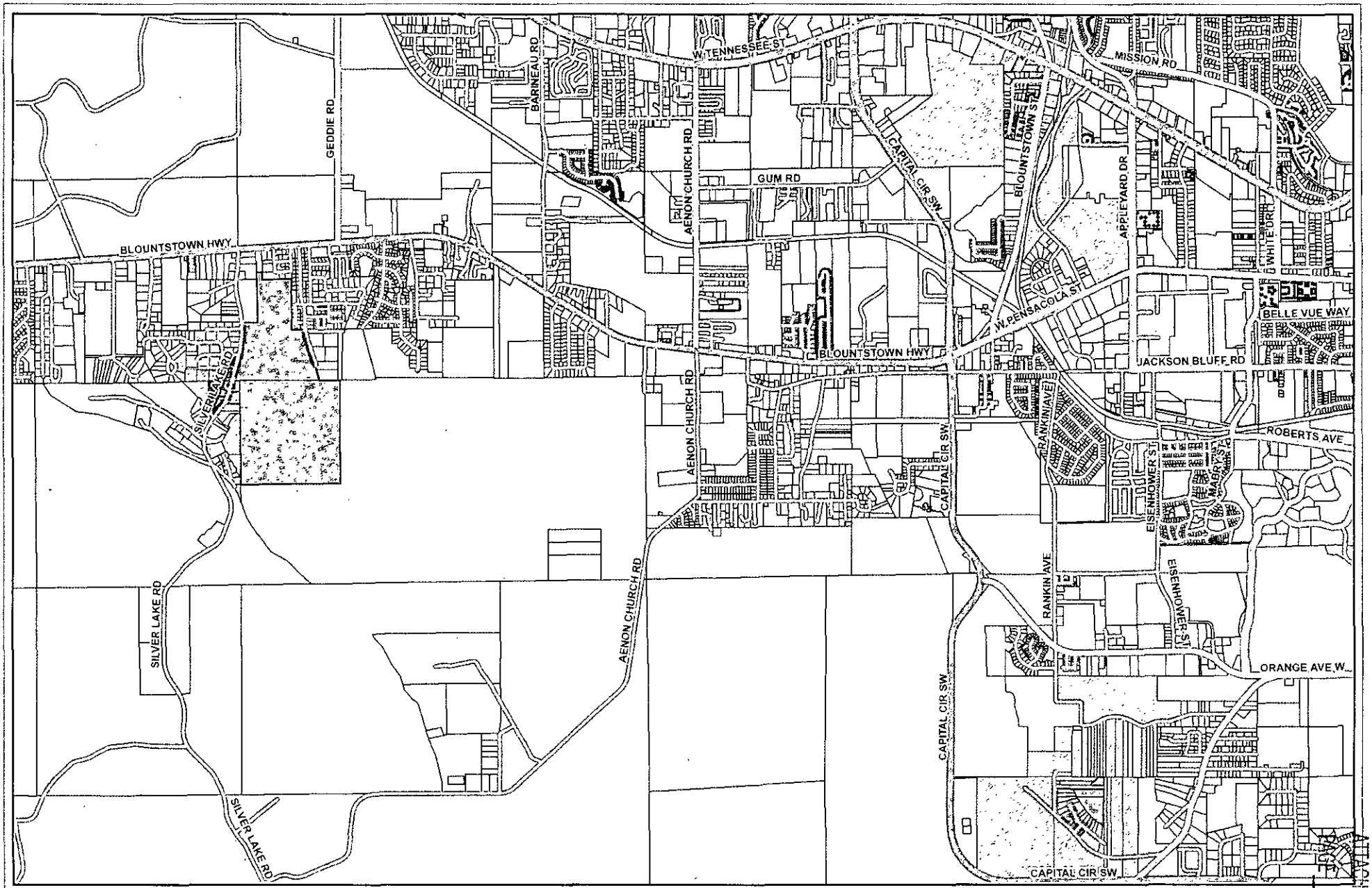
300 FT BUFFER
1400 FT BUFFER
Parcels

Roads
Interstate
Arterial
Collector
Local

Examples of Impacted Parcels
Central (Downtown)
(No Spray Buffers)

0 0.3 0.6 1.2 Miles

ATTACHMENT # 14
PAGE 1 OF 5



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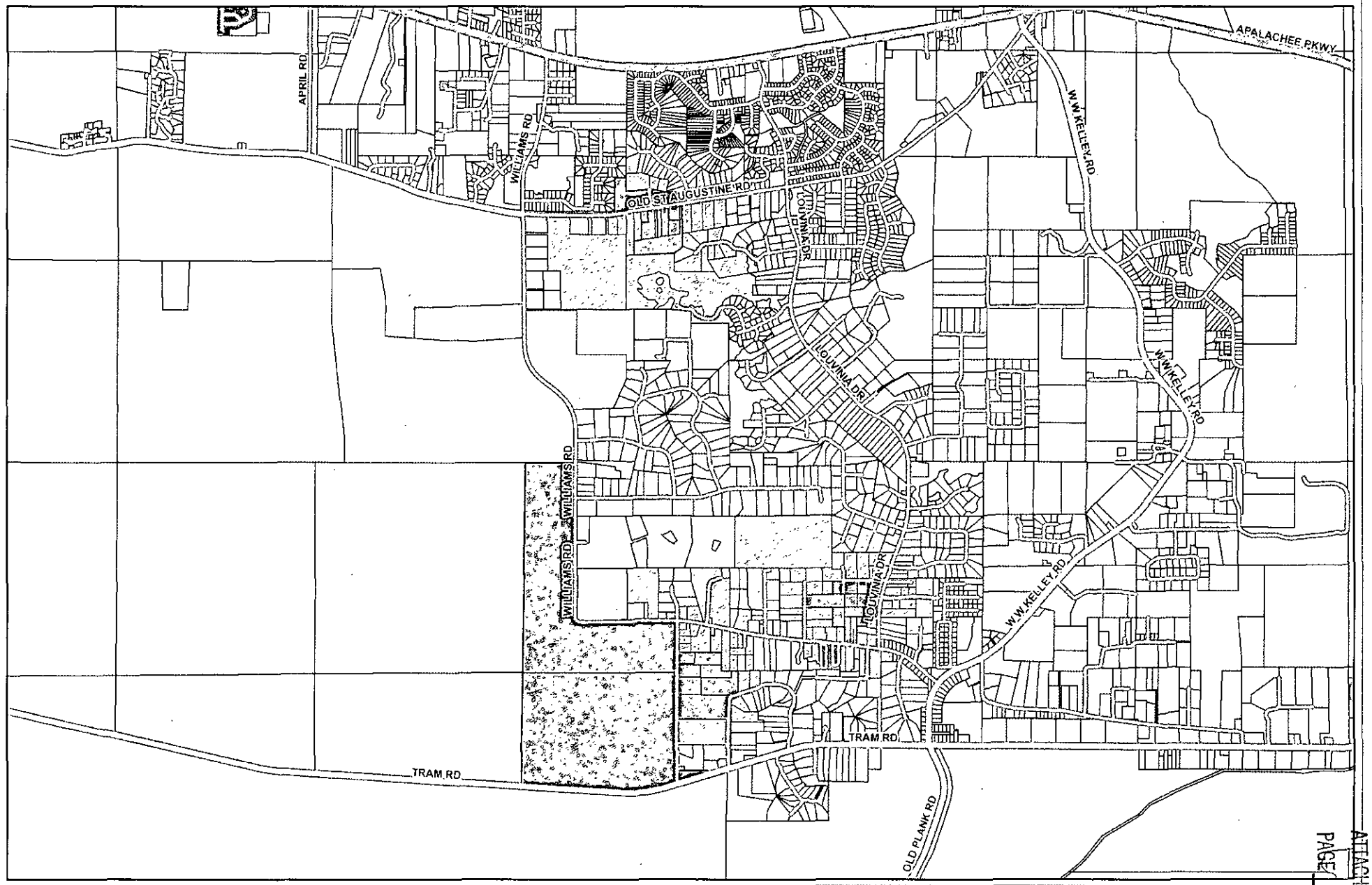
300 FT BUFFER
1400 FT BUFFER
Parcels

Roads
Interstate
Arterial
Collector
Local

Examples of Impacted Parcels
Southwest Area
(No Spray Buffers)

0 0.4 0.8 1.6 Miles

ATTACHMENT #
2 OF 5



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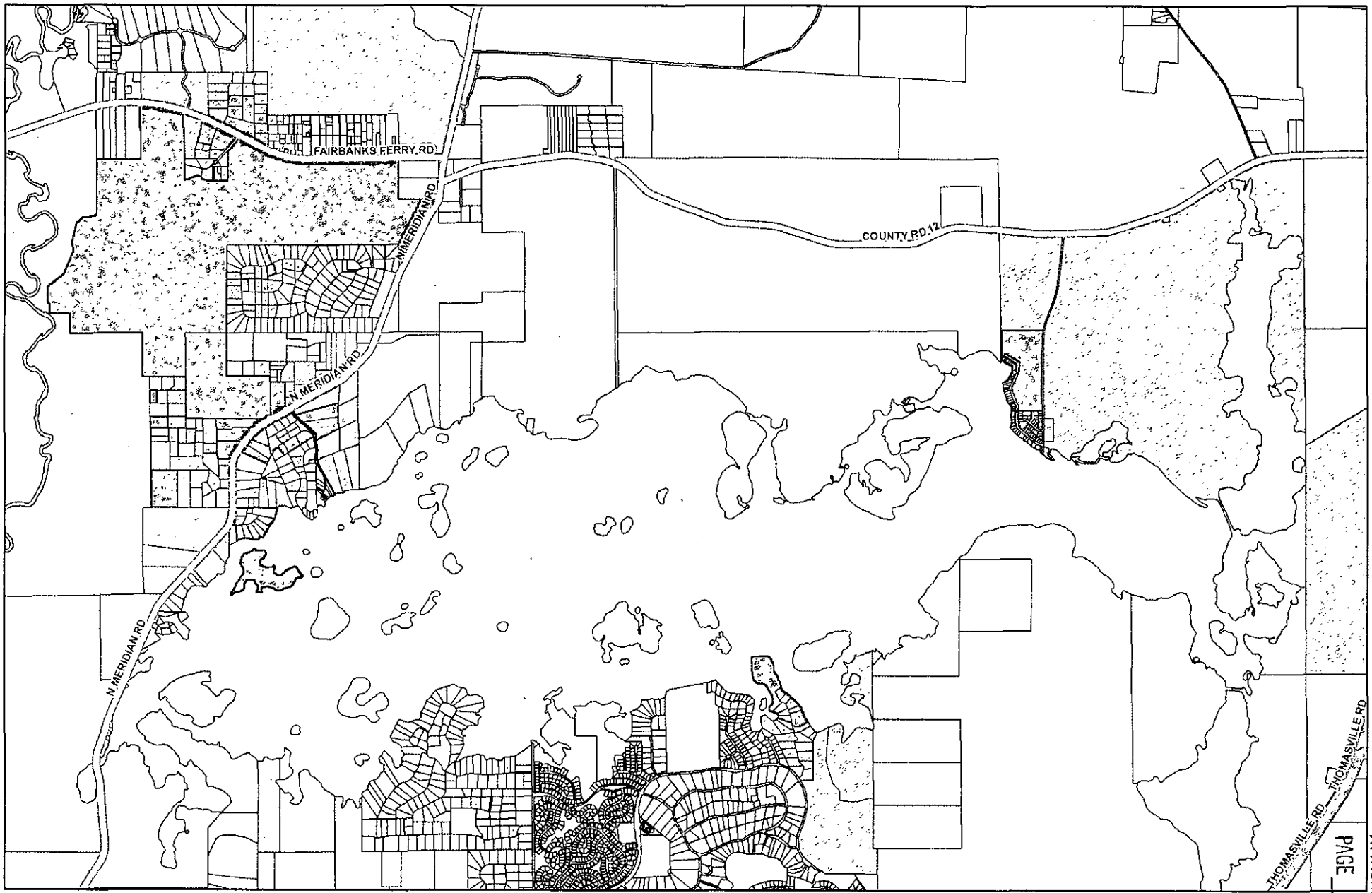
300 FT BUFFER
1400 FT BUFFER
Parcels

Roads
Interstate
Arterial
Collector
Local

Examples of Impacted Parcels
Southeast Area
(No Spray Buffers)

0 0.4 0.8 1.6 Miles

ATTACHMENT # 11
PAGE 3 OF 5



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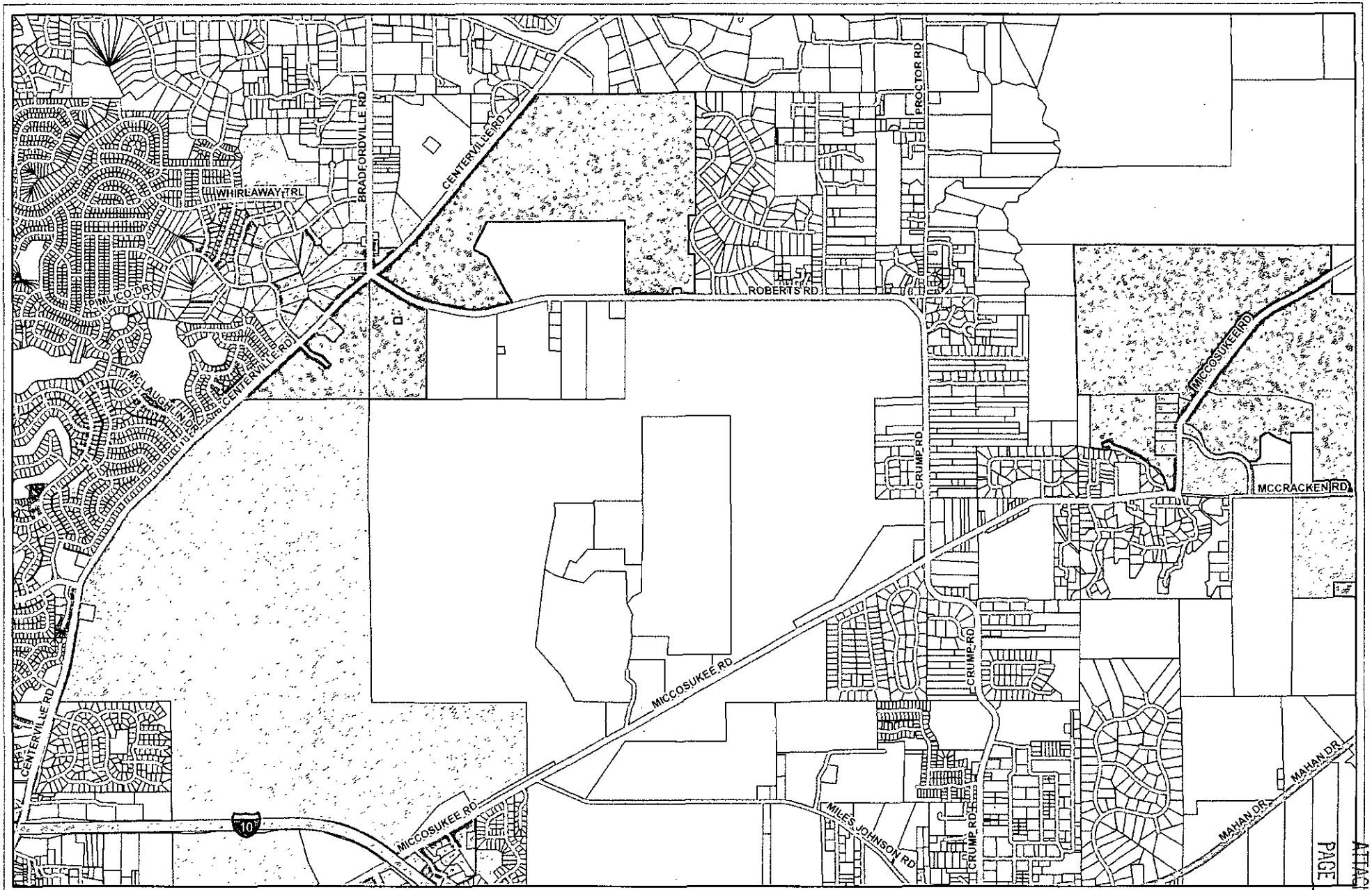
300 FT BUFFER
1400 FT BUFFER
Parcels

Roads
Interstate
Arterial
Collector
Local

Examples of Impacted Parcels
Northwest Area
(No Spray Buffers)

0 0.45 0.9 1.8 Miles

ATTACHMENT # 11
PAGE 4 OF 5



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300 FT BUFFER
1400 FT BUFFER
Parcels

Roads
Interstate
Arterial
Collector
Local

Examples of Impacted Parcels
Northeast Area
(No Spray Buffers)

0 0.375 0.75 1.5 Miles

ATTACHMENT # 11
PAGE 5 OF 5

Alternative Policy Formulation & Implementation For Mosquito Control

Eric Schreiber, Ph. D.
Sarasota County
Sarasota Mosquito Management Services

The use of the Precautionary principle

- **"When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."**

Mission Statement

To reduce mosquito numbers in an environmentally responsible manner to lessen the nuisance and disease risk to people in Sarasota County

- Commitment to maintaining & enhancing the County as a good place to live and work.
- Emphasis on comprehensive, quality public services as the County's primary contribution to the community's economic development effort.

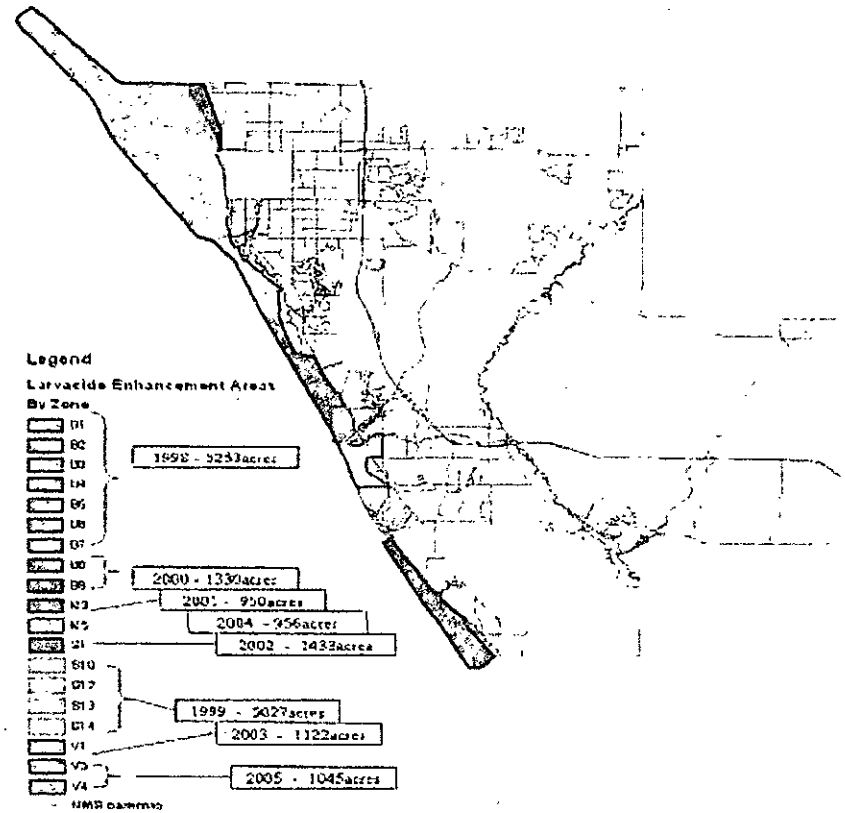
IPM Focus

- **Our focus is to use integrated pest management (IPM) methods to prevent or reduce to tolerable levels the mosquitoes that can bite people.**
- **IPM requires the combined use of cultural, physical, biological, & chemical tools to manage mosquitoes affecting people in ways that are safe and environmentally friendly.**
  - Work with other public & private entities to promote policies and programs that encourage education, training, workforce development, and basic & advanced/technological skills enhancement
  - Provide assistance to business & industry with regards to County process and procedures.

Prevention

- Input in new construction storm water systems through the permitting process
- Distribution of mosquito fish in newly-constructed storm water systems and to homeowners
- Establishment of ARAs
  - (adulticide reduction areas)

ARAs: Adulticide Reduction Areas means less adult spray more intensified IPM techniques



Adulticide Reduction Areas (ARAs)

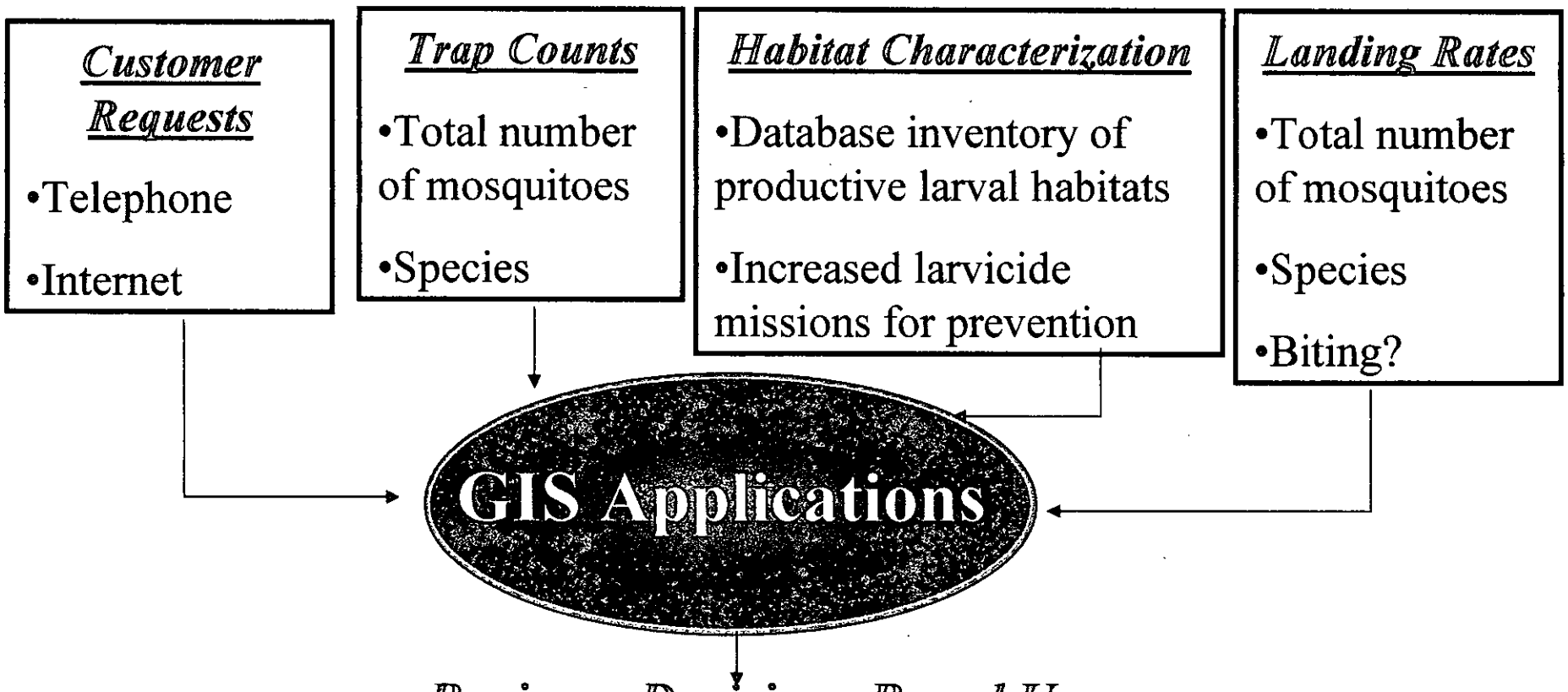
[Reduce by 75% Truck Spraying]

History

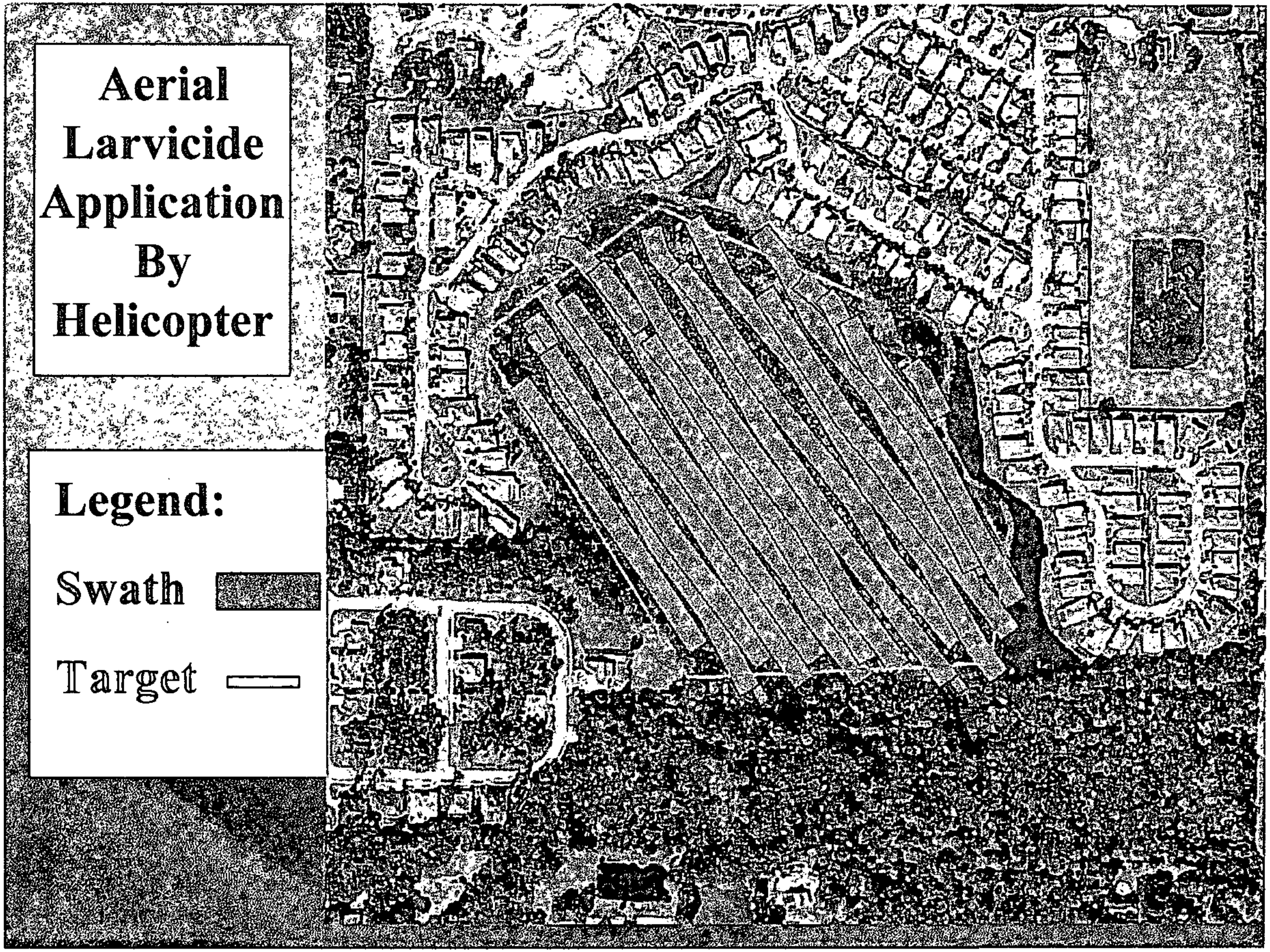
- First ARA developed in 1998 along coastal areas
- 1999- Sarasota ARA
- 2000- Coastal ARAs split (North & South) and expanded.
- 2001-Laurel Area (Sarasota Bay ARA)
- 2002-2005 increases in existing ARAs continued

Current

- Intensive inspection & larviciding in ARAs
- Use least toxic larvicide wherever practical
- Spot treat for adult mosquitoes if needed
- Use both larvicides and adulticides in adjacent buffer areas



- **Where are most of the service requests located?**
- **Where are the mosquito traps with the highest numbers?**
- **Where are the unacceptably high landing rates?**
- **Which larval habitats will produce mosquitoes soon?**



ATTACHMENT # 12
PAGE 9 OF 11

Policy guidelines for Chemical sensitive residents

- Based on science and not emotion
- Based on public health risk
  - Mosquito species of concern
  - Nuisance and disease potential
- Gradual implementation of program
  - Pilot program area
  - Assessment
    - Operational (Biological & Economic) perspective
    - Political Perspective
      - Buy-in : Commissioners & County Staff
      - Resources (labor & financial) commitment to have a chance to succeed and grow

Operational Implementations to reduce chemical sensitive residents concerns

- Develop a Standard Operating Procedure to implement program
  - Workshops w/stakeholders to pick a pilot program area and criteria. (Maybe facilitated or County Staff driven)

    Think of win-win outcomes
- Initiate a Pilot Program
  - Adequate measures to track progress and evaluate program
  - Time period (?) biology and weather probably will dictate
- Itemized Budget devoted to program
- Training of personnel to implement program
- Annual Review of Pilot Program

Mosquitoes and Mosquito Repellents: A Clinician's Guide

Mark S. Fradin, MD

This paper is intended to provide the clinician with the detailed and scientific information needed to advise patients who seek safe and effective ways of preventing mosquito bites. For this review, clinical and analytical data were selected from peer-reviewed research studies and review articles, case reports, entomology texts and journals, and government and industry publications. Relevant information was identified through a search of the MEDLINE database, the World Wide Web, the Mosquito-L electronic mailing list, and the Extension Toxicology Network database; selected U.S. Army, U.S. Environmental Protection Agency, and U.S. Department of Agriculture publications were also reviewed.

N,N-diethyl-3-methylbenzamide (DEET) is the most effective, and best studied, insect repellent currently on the market. This substance has a remarkable safety profile after 40 years of worldwide use, but toxic reactions can occur (usually when the product is misused). When DEET-based repellents are applied in combination with permethrin-treated clothing, protection against bites of nearly 100% can be achieved. Plant-based repellents are generally less effective than DEET-based products. Ultrasonic devices, outdoor bug "zappers," and bat houses are not effective against mosquitoes. Highly sensitive persons may want to take oral antihistamines to minimize cutaneous reactions to mosquito bites.

This paper is also available at http://www.acponline.org.

Ann Intern Med. 1998;128:931-940.

The quest to make humans less attractive to mosquitoes has fueled decades of scientific research on mosquito behavior and control. In the United States, mosquito bites are mostly a nuisance. Worldwide, however, mosquitoes transmit disease to more than 700 000 000 people annually and will be responsible for the deaths of 1 of every 17 people currently alive (1). Malaria results from infection with a protozoan carried by mosquitoes and, according to reports from the World Health Organization, causes as many as 3 000 000 deaths annually (2). Mosquitoes transmit the arboviruses responsible for yellow fever, dengue hemorrhagic fever, epidemic polyarthritis, and several forms of encephalitis (some of which are found in the United States). Bancroftian filariasis is caused by a nematode transmitted by mosquito bite.

Historically, the strategies for reducing the incidence of mosquito-borne disease have been two-pronged, centering around habitat control (through chemical and biological means) and the use of personal protection in the form of insect repellents. This paper reviews the scientific data on chemical (synthetic) and natural (plant-derived) insect repellents currently available, debunks some of the popular myths about alternative repellents, reviews effective techniques for reducing mosquito populations in the local environment, and provides the clinician with the practical information needed to advise patients on how to safely and effectively reduce their likelihood of being bitten by mosquitoes.

Methods

By doing a MEDLINE search with the keywords *DEET, insect repellents, mosquito, citronella,* and *permethrin,* pertinent articles published in English-language journals between 1966 and 1997 were identified and reviewed. The World Wide Web and the Extension Toxicity Network database were also searched for toxicology data and other pertinent information. Selection from the bibliographies of relevant articles augmented the database search. Major distributors of natural insect repellents were contacted and asked to provide scientific data, if available, supporting the efficacy of their products.

The Mosquito Life Cycle

Mosquitoes are found all over the world, except in Antarctica. These two-winged insects belong to the order Diptera. Members of the genera *Anopheles, Culex,* and *Aedes* are most commonly responsible for bites in humans. There are approximately 170 species of mosquitoes in North America alone.

To develop, mosquitoes require an environment of standing water. As a group, they have adapted to complete their life cycle in diverse aquatic habitats, including fresh water; salt water marshes; brackish water; or water found in containers, old tires, or tree holes. The life cycle of the mosquito has four stages. The female mosquito lays her eggs, up to several hundred at a time, on the surface of the water or in an area subject to flooding. Unhatched eggs of some species can withstand weeks to months of desiccation, remaining viable until the right conditions for hatching occur. The eggs of most species hatch in 2 to 3 days, and the larvae feed on organic matter in the water for about a week until they change into pupae. The pupae live at the surface of the water for 2 to 3 days before metamorphosing into adult mosquitoes.

Only female mosquitoes bite. Male mosquitoes feed primarily on flower nectar, whereas female mosquitoes require a blood meal to produce eggs. They usually feed every 3 to 4 days; in a single feeding, a female mosquito typically consumes more than its own weight in blood (3). Certain species of mosquitoes prefer to feed at twilight or nighttime; others bite mostly during the day.

Some mosquito species are zoophilic (preferring to feed on animals) and others are anthropophilic (showing a preference for human blood). In some mosquito species, seasonal switching of hosts provides a mechanism for transmitting diseases from animal to human. (It is worth noting, however, that mosquitoes cannot transmit HIV because the virus neither survives nor replicates in mosquitoes and the blood from the last bitten person is not flushed into the next person during subsequent feeds. In addition, the circulating viral load of most HIV-infected persons is so low that the theoretical risk that a mosquito bite would transmit HIV is estimated to be less than 1 in 10 000 000 [4, 5].)

Stimuli That Attract Mosquitoes

The factors involved in attracting mosquitoes to a host are complex and are not fully understood (6–11). Mosquitoes use visual, thermal, and olfactory stimuli to locate a host. Of these, olfactory cues are probably most important. For mosquitoes that feed during the daytime, movement of the host and the wearing of dark-colored clothing may initiate orientation toward a person (3, 12). Visual stimuli seem to be important for in-flight orientation, particularly over long ranges, whereas olfactory stimuli become more important as a mosquito nears its host.

It has been estimated that 300 to 400 compounds are released from the body as by-products of metabolism and that more than 100 volatile compounds can be detected in human breath (9). Of these odors, only a fraction have been isolated and fully characterized. Carbon dioxide and lactic acid are the two best-studied mosquito attractants. Carbon dioxide, released mainly from breath but also from skin, serves as a long-range airborne attractant and can be detected by mosquitoes at distances of up to 36 meters (3, 13–15). Lactic acid, in combination with carbon dioxide, is also an attractant. Mosquitoes have chemoreceptors on their antennae that are stimulated by lactic acid. These same receptors may be inhibited by N,N-diethyl-3-methylbenzamide (DEET)–based insect repellents (16).

At close range, skin temperature and moisture serve as attractants (3, 9, 17). Different species of mosquitoes may show strong biting preferences for different parts of the human body (such as the head or feet), which may be related to local skin temperature and eccrine sweat gland output (18, 19). Anhidrotic persons show markedly decreased attractiveness to mosquitoes (6). Other volatile compounds, derived from sebum, eccrine and apocrine sweat, or the cutaneous microflora bacterial action on these secretions, may also act as chemoattractants (6, 20, 21). Whole-host odors are more attractive than carbon dioxide and lactic acid alone (22). Floral fragrances from perfumes, soaps, lotions, and hair-care products may also attract mosquitoes (23).

The attractiveness of different persons to the same or different species of mosquitoes varies substantially (17, 24). In general, adults are more likely to be bitten than children (17, 25), although adults may become less attractive to mosquitoes as they age (6). Men are bitten more readily than women (3, 26). Larger persons tend to attract more mosquitoes, perhaps because of their greater relative heat or carbon dioxide output (27).

Insect Repellents

Despite the obvious desirability of finding an effective oral mosquito repellent, no such agent has been identified (28, 29). Thus, the search for the perfect topical insect repellent continues. This ideal agent would repel multiple species of biting arthropods, remain effective for at least 8 hours, cause no irritation to the skin or mucous membranes, cause no systemic toxicity, be resistant to abrasion and rub-off, and be greaseless and odorless. No available insect repellent meets all of these criteria.

Efforts to find such a compound have been hampered by the numerous variables that affect the inherent repellency of any chemical. Repellents do not all share a single mode of action, and surprisingly little is known about how repellents act on their target insects (30, 31). Moreover, different species of mosquitoes may react differently to the same repellent (32).

To be effective, a repellent must show an optimal degree of volatility, making it possible for an effective repellent vapor concentration to be maintained at the skin surface without evaporating so quickly that it loses its effectiveness. Many factors play a role in how effective any repellent is, including the frequency and uniformity of application, the number and species of the organisms attempting to bite, the user's inherent attractiveness to blood-sucking arthropods, and the overall activity level of the potential host (33). Abrasion from clothing, evaporation and absorption from the skin surface, wash-off from sweat or rain, higher temperatures, or a windy environment all decrease repellent effectiveness (17, 34–37). Each 10 °C increase in temperature can

Table 1. Repellents That Contain DEET*

Manufacturer, Location, Telephone Number	Product Brand Name	Available Forms	Concentration of DEET, %†
Amway Corp., New York, New York			
800-544-7167	HourGuard 8	Aerosol spray	25.0
	HourGuard 12	Cream	35.0
Minnetonka Brands, Inc., Eden Praine, Minnesota			
800-243-2929	Skedaddle Insect Protection for Children	Lotion	6.5
	Skedaddle for Children with Sunscreen (SPF 15)	Lotion	6.5
	Skedaddle 4-Hour Insect Protection	Lotion	10.0
Sawyer Products, Tampa, Florida			
800-940-4464	DEET Plus	Lotion, pump spray	17.5
	Sawyer Gold	Lotion, pump spray	17.5
	Sawyer 30	Lotion	30.0
	Deet Plus	Spray aerosol	38.0
	Maxi-DEET	Solution, pump spray	100.0
S.C. Johnson Wax, Racine, Wisconsin			
800-558-5566	OFF! Skintastic for Kids Unscented	Pump spray	5.0
	OFF! Skintastic Unscented	Pump spray	7.0
	OFF! Skintastic Fresh Scent	Lotion	7.5
	OFF! Skintastic Unscented	Lotion	7.5
	OFF! Unscented	Aerosol spray	15.0
	Deep Woods OFF! Unscented	Aerosol spray	30.0
	Deep Woods OFF! for Sportsmen	Aerosol spray	30.0
	Maximum Protection Deep Woods OFF!	Pump spray	100.0
	Deep Woods OFF! for Sportsmen	Pump spray	100.0
Tender Corp., Littleton, New Hampshire			
800-258-4696	Ben's Backyard	Lotion, pump spray	24.0
	Ben's Wilderness	Aerosol	27.0
	Ben's Max 100	Lotion, pump spray	100.0
United Industries Corp., St. Louis, Missouri			
800-767-9927	Cutter Just for Kids	Pump spray	5.0
	Cutter Pleasant Protection with Sunscreen (SPF 15)	Aerosol, pump spray	7.0
	Cutter Unscented	Aerosol spray	10.0
	Cutter Lotion with Sunscreen (SPF 15)	Lotion	10.0
	Cutter Backwoods Unscented	Aerosol spray	23.0
	Cutter Outdoorsman Unscented	Aerosol spray, lotion, stick	30.0
Wisconsin Pharmacal Co., Jackson, Wisconsin			
800-558-6614	Repel Soft Scented	Gel	7.0
	Repel Camp Lotion for Kids	Lotion	10.0
	Repel Soft Scented	Pump spray	18.0
	Repel Family Formula	Pump spray	18.0
	Repel Sportsman Formula	Pump spray	18.0
	Repel Unscented Sun Block (SPF 15)	Lotion	20.0
	Repel Sportsman Formula	Lotion	20.0
	Repel Soft Scented	Lotion	20.0
	Repel Family Formula	Aerosol	23.0
	Repel Classic Sportsman Formula	Aerosol	40.0
	Repel 100	Pump spray	100.0

* DEET = *N,N-diethyl-3-methylbenzamide*, SPF = sun protection factor.
† Some manufacturers give only the concentration of the *m*-isomer, others list total concentrations of all DEET isomers. Technical-grade 100% DEET comprises 95% *m*-isomer and 5% other isomers.

lead to as much as a 50% reduction in protection time (37). The repellents currently available must be applied to all exposed areas of skin; unprotected skin a few centimeters away from a treated area can be attacked by hungry mosquitoes (33, 35).

Chemical Insect Repellents

N,N-Diethyl-3-Methylbenzamide (DEET)

Previously called N,N-diethyl-m-toluamide, N,N-diethyl-3-methylbenzamide (DEET) remains the gold standard of currently available insect repellents. This substance was discovered and developed by scientists at the U.S. Department of Agriculture and was patented by the U.S. Army in 1946. It was subsequently registered for use by the general public in 1957. It is a broad-spectrum repellent that is effective against mosquitoes, biting flies, chiggers, fleas, and ticks. Twenty years of empirical testing of more than 20 000 other compounds has not resulted in another marketed chemical product with the duration of protection and broad-spectrum effectiveness of DEET (30, 33, 38–41). The U.S. Environmental Protection Agency (EPA) estimates that more than 38% of the U.S. population uses a DEET-based insect repellent every year and that worldwide use exceeds 200 000 000 people annually (42).

Formulation of Available Products with DEET

In the United States, DEET is available in 5% to 100% concentrations in multiple formulations, including solutions, lotions, creams, gels, aerosol and pump sprays, and impregnated towelettes (Table 1).

Until 1989, the standard-issue insect repellent of

Table 2. Suggested Guidelines for Safe Use of Insect Repellents*

Use just enough repellent to lightly cover the skin; do not saturate the skin
Repellents should be applied only to exposed skin, clothing, or both. Do not use under clothing
To apply to the face, dispense into palms, rub hands together, and apply thin layer to face
Avoid contact with eyes and mouth. To prevent subsequent contact with mucous membranes, do not apply repellent to children's hands
After applying, wipe repellent from the surfaces of the palms to prevent inadvertent contact with eyes, mouth, and genitals
Never use repellents over cuts, wounds, inflamed, irritated, or eczematous skin
Do not inhale aerosol formulations or get in eyes
Frequent reapplication of repellent is unnecessary
Once inside, wash treated areas with soap and water

* Adapted from reference 55

the U.S. military consisted of 75% DEET in an alcohol base. Complaints about the aesthetic feel of this product and concerns about potential toxicity under long-term daily use led to U.S. Army–sponsored studies to produce new formulations. The 3M Company (St. Paul, Minnesota) developed a slow-release, polymer-based product containing 35% DEET; this has become the repellent provided to all U.S. military personnel. This product is available to the general public exclusively through the Amway Corporation (New York, New York) under the brand name HourGuard (**Table 1**). If lower-strength formulations of extended-release DEET are desired, Minnetonka Brands (Eden Prairie, Minnesota) offers products containing 6.5% and 10% DEET (**Table 1**).

Efficacy

As a general rule, higher concentrations of DEET provide longer-lasting protection. Unfortunately, no guidelines are available to help consumers decide what concentration of DEET is appropriate for their specific needs. The number of variables that affect a repellent's effectiveness precludes assigning an "insect repellent factor" to individual products.

Mathematical models of the effectiveness and persistence of mosquito repellents show that the protection offered by a repellent is proportional to the logarithm of the dose (concentration of the product). This curve tends to form a plateau at higher repellent concentrations, providing relatively less additional protection for each incremental dose of DEET that exceeds a 50% concentration (43, 44). In one laboratory study, 50% DEET provided about 4 hours of protection against *Aedes aegypti* mosquitoes, but increasing the DEET concentration to 100% provided only 1 additional hour of protection (45). In another study, 12.5% DEET provided over 6 hours of protection against *Aedes albopictus*; doubling the DEET concentration to 25% increased the protection time only to about 8 hours (46).

Extended-release formulations of DEET have made it possible to reduce the repellent concentration without sacrificing duration of action. When tested under laboratory and several different environmental and climatic field conditions, the 35% DEET polymer formulation by the 3M Corporation was as effective as 75% DEET in repelling mosquitoes (19, 47–50). The polymer formulation provided up to 12 hours of more than 95% protection, depending on the environmental conditions and species of mosquito tested (46, 48, 49, 51). One study showed that Minnetonka Brands' 6.5% liposphere microdispersion of DEET was effective for up to 2.5 hours and that their 10% product was effective for about 1 hour longer (52).

How To Choose and Apply DEET Repellents

For casual use, a high concentration of DEET is not needed. Products with 10% to 35% DEET will provide adequate protection under most conditions. The American Academy of Pediatrics recommends that repellents used on children contain no more than 10% DEET (53, 54). Products with a DEET concentration of more than 50% are probably best reserved for circumstances in which insect biting pressures are intense and in which other factors, such as high temperature and humidity, may promote rapid loss of repellent from the skin surface. The EPA issued guidelines to consumers about proper application of insect repellents (**Table 2**) (55).

Repellents may be applied directly to the skin or to clothing, window screens, mesh insect nets, tents, or sleeping bags. Persons who are particularly concerned about potential toxicity from DEET may limit application of the repellent to their clothes. If DEET-treated garments are stored in a plastic bag between wearings, the repellent effect can last for many weeks (24).

Repellents containing DEET must be carefully applied because they can damage plastics (such as watch crystals and eyeglasses frames), rayon, spandex, other synthetic fabrics, leather, and painted or varnished surfaces. DEET does not damage natural fibers, such as cotton or wool, and has no effect on nylon. The lay literature contains many accounts of the unpleasant odor or greasy feel of DEET, but careful testing has shown a full spectrum of aesthetic responses to these products (56).

Consumers who apply both a DEET-based insect repellent and a sunscreen should be aware that the repellent may reduce the sunscreen's effectiveness. A limited study in 14 volunteers using the 3M polymer-based 33% DEET repellent and a sunscreen with sun protection factor 15 revealed a mean decrease in sun protection factor of 33.5% when the two agents were applied sequentially (57). Combination products in which the insect repellent and sunscreen

have been formulated together, however, would be expected to provide the sun protection factor stated on the label.

Pharmacology

Numerous studies have evaluated the percutaneous absorption, metabolism, and rate of excretion of DEET (58–61). Initial data suggested that 9% to 56% of the applied dose was absorbed through the skin (59). A carefully conducted study from 1995 that used human volunteers showed that the average dermal absorption of 100% DEET was 5.6%; for 15% DEET in ethanol, an average of 8.4% of the dose was absorbed (58). Because of its lipophilic nature, DEET was rapidly absorbed within 2 hours after application; was eliminated from the plasma within 4 hours after being rinsed off the skin; and was primarily excreted in the urine, mostly within 12 hours. Tape stripping revealed that the chemical does not accumulate in the stratum corneum.

Bioavailability experiments conducted with Minnetonka Brands' 10% DEET liposphere formulation showed that percutaneous absorption was one third of that of a 10% alcohol-based DEET solution (52). In contrast, U.S. Army studies that used an in vitro pigskin model did not show any reduced percutaneous absorption (expressed as a percentage of the applied dose) of the 3M polymer formulation compared with 75% DEET in alcohol (62).

Table 3. Studies Done To Support the Reregistration of DEET with the U.S. Environmental Protection Agency*

Mammalian toxicology studies
Rat, 90-day dermal test
Castrated male rat, 90-day dermal test
Micropig, 2-week dermal dose range–finding study
Micropig, 90-day dermal study
Rat, 90-day multistrain oral administration; done to evaluate renal toxicity
Hamster, 2-week dose range–finding study
Hamster, 90-day dose range–finding study
Rat, 90-day dose range–finding study
Rat, two-generation reproduction study
Rat, long-term toxicity and oncogenicity study
Mouse, 90-day dose range–finding study
Mouse, oncogenicity study
Rat, teratology dose range–finding study
Rat, teratology study
Rabbit, teratology dose range–finding study
Rabbit, teratology study
Rat, short-term oral-dose range–finding study
Rat, short-term neurotoxicity study
Rat, long-term neurotoxicity study
Dog, 2-week diet palatability study
Dog, 8-week dietary dose range–finding study
Dog, 3-week dietary toxicity study
Dog, 2-week oral gelatin capsule administration
Dog, 8-week oral gelatin capsule dose range–finding (first study)
Dog, 8-week oral gelatin capsule dose range–finding (second study)
Dog, long-term toxicity study
Determination of expired volatiles after oral and dermal administration
Pharmacokinetic and comparative dermal absorption tests
Human dermal absorption test
Mutagenicity studies
Ames test
Chromosome aberrations
Unscheduled DNA synthesis
Ecotoxicology studies
Bobwhite quail short-term oral toxicity study
Daphnid short-term toxicity study

* See reference 64. DEET = N,N-diethyl-3-methylbenzamide.

Toxicity

Used by millions of people worldwide for 40 years, DEET has a remarkable safety profile. As part of the 1980 EPA Reregistration Standard for DEET, more than 30 studies were conducted to assess acute, chronic, and subchronic toxicity; mutagenicity; oncogenicity; and developmental, reproductive, and neurologic toxicity (Table 3) (42, 63, 64). The results of these studies did not require any change to the product to comply with EPA safety standards, nor did they indicate any new toxicities with normal use. Studies of high doses of DEET orally administered to mice and rats did not reveal any potential in humans for teratogenicity or oncogenicity.

Case reports of potential DEET toxicity exist in the medical literature and are summarized in Table 4. The reports of greatest concern involve 14 cases of encephalopathy, 13 of which were in children younger than 8 years of age (63, 66–71, 75). Three of these children died, 1 of whom had an ornithine carbamoyl transferase deficiency (67) that might have predisposed her to DEET-induced toxicity (66). The other children recovered without sequelae. Many of these persons had a history of long-term, excessive, or inappropriate use of DEET repellents, and the details of exposure are frequently poorly documented. Animal studies in rats and mice have shown that DEET is not a selective neurotoxin (42, 61, 63).

Toxicology studies in rats and dogs in which sublethal intraperitoneal injections were used revealed that DEET could induce dose-dependent hypotension and bradycardia; however, these conditions occurred at dosages that would be almost impossible to attain with cutaneous applications of DEET (78). Only one case of bradycardia and hypotension has been documented in the medical literature (79).

Initial repeat-insult patch tests of 100% technical-grade DEET or 50% DEET in ethanol conducted over 21 consecutive days showed no sign of skin irritation (42). Subsequently, 14 cases of contact urticaria and irritant contact dermatitis (mostly in soldiers) have been reported (81–85). The antecubital fossa seems to be particularly sensitive to developing bullous irritant contact dermatitis if DEET products are allowed to remain on this area overnight (86).

A 1994 study reviewed 9086 cases of DEET exposure reported to 71 poison control centers from 1985 to 1989 (76). More than half (54%) of the persons involved had no symptoms at the time of the call to the poison control center. The most

Table 4. Reported Major Signs and Symptoms Attributed to Exposure to DEET*

Affected Area	Signs or Symptoms	Cases	Age	Sex	Concentration of DEET	Details of Use	Outcome	Reference
		n			%			
Central nervous system	Lethargy, confusion, acute manic psychosis	1	30 years	Male	Unknown	Three-week, daily, whole-body application, followed by 2 to 3 hours per day in a sauna	Resolved, no sequelae	65
	Lethargy, headaches, ataxia, disorientation	1	6 years	Female	15	>10 applications	Death (heterozygous for ornithine carbamoyl transferase deficiency)	66, 67
	Acute encephalopathy	1	17 months	Female	20	"Frequent" for 3 weeks	Death	68
	Headaches, disorientation, ataxia, convulsions	1	5 years	Female	10	Nightly for 3 months	Death	69
	Behavioral changes, confusion, tremors, seizures, encephalopathy	10	8 years or younger	Male (n = 6) Female (n = 4)	10–95	Concentration of DEET known in only 5 of 11 cases. Number of applications varied from 2 to 90. Many reports note "daily," "heavy," "frequent," or "whole-body" use	Resolved, no sequelae	63, 69–75
		1	29 years	Male				
	Seizures, hypotension, coma	6	1–33 years	Male (n = 4) Female (n = 2)	47.5–90	Ingested > 50 mL of DEET	3 of 6 patients died Resolved in 3 of 6 patients, no sequelae	76, 77
Cardiovascular	Bradycardia, hypotension	1	61 years	Female	Unknown	"Liberal" application to all exposed skin before gardening	Resolved, no sequelae	78, 79
Cutaneous or allergic reaction	Anaphylaxis	1	42 years	Female	52	Touched companion who had just applied DEET insect repellent	Resolved, no sequelae	80
	Wheals	3	4 years 35 years	Male (n = 2) Female (n = 1)	Unknown	Urticaria developed 10 to 30 minutes after application	Resolved	81–83
	Hemorrhagic bulla and erosions; confined to the antecubital fossa	11	18–20 years	Male	33–50	Military personnel; applied to all exposed skin, then slept outdoors with repellent still on skin	Resolved in 9 of 11 patients; scarring in 2 of 11	84, 85

* DEET = *N,N*-diethyl-3-methylbenzamide

commonly reported symptoms were related to spraying repellent in the eyes (DEET is a known eye irritant [42]) or inhaling it. Symptoms were least likely to occur after accidental ingestion of small amounts of the repellent. Although most exposures were in children, there was no evidence that children younger than 6 years of age were more likely than older children or adults to develop adverse effects after use of a DEET repellent. No correlation was found between the severity of symptoms and age, sex, or concentration of applied DEET. Eighty-eight percent of exposed persons did not require treatment at a health care facility. Of the patients who were seen, 81% were sent home, and only 5% required hospitalization. Of the patients in whom follow-up was available, 99% had no long-term sequelae.

In summary, DEET has had a remarkable safety profile during more than 40 years of use by millions of people worldwide. Careful product choice and application of the repellent according to EPA guidelines will greatly reduce the possibility of toxicity. Conservative use of low-concentration DEET products is most appropriate for children.

Questions about the safety of DEET may be addressed to the EPA-sponsored National Pesticide Telecommunications Network, available by telephone every day from 6:30 a.m. to 4:30 p.m. Pacific Standard Time at 800-858-7378 or on the World Wide Web at http://www.ace.orst.edu/info/nptn/.

Skin-So-Soft

Avon (New York, New York) Skin-So-Soft bath oil received considerable media attention several years ago when some consumers reported it to be effective as a mosquito repellent. When tested under laboratory conditions against *Aedes aegypti* mosquitoes, this product's effective half-life was 30 minutes. Against *Aedes albopictus*, Skin-So-Soft oil provided 40 minutes of protection from bites, a duration 10 times less than that of 12.5% DEET (46). It has been proposed that the limited mosquito

repellent effect of Skin-So-Soft oil could be caused by its fragrance or the presence of diisopropyl adipate and benzophenone in the formulation, both of which have some repellent activity (40). Avon now markets products under the Skin-So-Soft label that contain an EPA-recognized repellent (Table 5).

Plant-Derived Repellents

Thousands of plants have been tested as potential sources of insect repellents (39, 40, 87). None of the plant-derived chemicals tested to date demonstrate the broad effectiveness and duration of DEET, but a few show repellent activity. Plants whose essential oils have been reported to have repellent activity include citronella, cedar, verbena, pennyroyal, geranium, lavender, pine, cajeput, cinnamon, rosemary, basil, thyme, allspice, garlic, and peppermint (40, 88–91). Unlike synthetic insect repellents, plant-derived repellents have been relatively poorly studied. When tested, most of these essential oils tended to give short-lasting protection, usually less than 2 hours. Readily available plant-derived insect repellents are listed in Table 5.

Citronella

Citronella is the active ingredient most commonly found in "natural" or "herbal" insect repellents marketed in the United States. It is registered with the EPA as an insect repellent. Citronella oil has a lemony scent and was originally extracted from the grass plant *Cymbopogon nardus*. Limited data are available from studies that directly compared the efficacy of citronella-based products with that of DEET-based products. In one study, 0.01 μmol of DEET per L of air was sufficient to prevent 90% of mosquitoes from landing on their targets; a 1000-fold higher concentration of citronellol (one of the active chemicals in citronella oil) was required to achieve a similar effect (31).

Studies show that citronella can be an effective repellent, but it provides shorter complete protection time than most DEET-based products. Frequent reapplication of the repellent can partially compensate for this. The manufacturer of Natrapel (Tender Corp., Littleton, New Hampshire) has laboratory data showing that their 10% lotion reduced mosquito bites by 84% during a 4-minute test period. In contrast, 14% DEET reduced biting by 96% in the same test period. Buzz Away (Quantum, Inc., Eugene, Oregon) with 5% citronella oil provided an average protection time of 1.9 hours against *Aedes aegypti* (92). In field testing, Buzz Away Oil provided an average of 88% repellency during a 2-hour exposure. In general, the repellency of Buzz Away was greatest within the first 40 minutes after appli-

Table 5. Plant-Derived Insect Repellents and Permethrin Insecticide Sprays*

Manufacturer, Location, Telephone Number	Product Brand Name	Forms	Active Ingredient
Avon Corp., New York, New York 800-367-2866	Skin-So-Soft Moisturizing Suncare Plus (SPF 8, 15, or 30)	Lotion	Citronella oil, 0.05%
	Skin-So-Soft Bug Guard	Pump spray	Citronella oil, 0.10%
Consep, Inc., Bend, Oregon 800-367-8727	Bite Blocker	Lotion, oil, pump spray	Soybean oil, 2%
Quantum, Inc., Eugene, Oregon 800-448-1448	Buzz Away	Towelette, pump spray	Citronella oil, 5%
	Buzz Away (SPF 15)	Lotion	
Tender Corp., Littleton, New Hampshire 800-258-4696	Natrapel	Lotion, pump spray	Citronella, 10%
All Terrain Co., Encinitas, California 800-246-7328	Herbal Outdoor Protection	Lotion	Citronella oil, 12%; oils of cedarwood, lavender, lemongrass, and peppermint
	Complete Outdoor Protection (SPF 20)	Lotion	
	Herbal Armor	Pump spray	Citronella oil, 15%; oils of clove, cedarwood, eucalyptus, lemongrass, peppermint, and garlic
Green Ban, Norway, Iowa 319-446-7495	Green Ban for People		
	Regular	Oil	Citronella oil, 5%; peppermint oil, 1%
	Double Strength	Oil	Citronella oil, 10%; peppermint oil, 2%
Coulston Products, Easton, Pennsylvania 610-253-0167	Duranon	Aerosol spray, pump spray	Permethrin, 0.5%
Sawyer Products, Tampa, Florida 800-940-4464	Permethrin Tick Repellent	Aerosol spray, pump spray	Permethrin, 0.5%
United Industries Corp., St. Louis, Missouri 800-767-9927	Cutter Outdoorsman Gear Guard	Aerosol spray	Permethrin, 0.5%
Wisconsin Pharmacal Co., Jackson, Wisconsin 800-558-6614	Repel Permanone	Aerosol spray	Permethrin, 0.5%

* SPF = sun protection factor

cation and decreased over the remainder of the test period (93).

Citronella candles have been promoted as an effective way to repel mosquitoes in the backyard. One study compared the ability of commercially available 3% citronella candles, 5% citronella incense, and plain candles to prevent bites by *Aedes* mosquitoes under field conditions (94). Persons near the citronella candles had 42% fewer bites than controls, who had no protection (a statistically significant difference). However, burning ordinary candles reduced the number of bites by 23%. The efficacy of citronella incense and plain candles did not differ. The ability of plain candles to decrease biting may result from their action as a decoy source of warmth, moisture, and carbon dioxide.

The citrosa plant (*Pelargonium citrosum* 'van Leenii') has been marketed as being able to repel mosquitoes through the continuous release of citronella oils. Unfortunately, when tested, these plants offer no protection against bites (95, 96).

Bite Blocker

Bite Blocker (Consep, Inc., Bend, Oregon) is a plant-based repellent that was released in the United States in 1997. Bite Blocker combines soybean oil, geranium oil, and coconut oil in a formulation that has been available in Europe for several years (97). Studies conducted at the University of Guelph, Ontario, Canada, showed that this product gave more than 97% protection against *Aedes* mosquitoes under field conditions, even 3.5 hours after application. During the same period, a 6.65% DEET-based spray afforded 86% protection, and Avon Skin-So-Soft citronella-based repellent gave only 40% protection (98). A second study showed that Bite Blocker provided a mean ± SD of 200 ± 30 minutes of complete protection from mosquito bites (99).

Permethrin

Pyrethrum is a powerful, rapidly acting insecticide, originally derived from the crushed and dried flowers of the daisy *Chrysanthemum cinerariifolium* (100). Permethrin is a human-made synthetic pyrethroid. It does not repel insects but works as a contact insecticide, causing nervous system toxicity that leads to the death or "knockdown" (out of the air) of the insect. The chemical is effective against mosquitoes, flies, ticks, and chiggers. Permethrin has low toxicity in mammals, is poorly absorbed by the skin, and is rapidly inactivated by ester hydrolysis (101).

Permethrin should be applied directly to clothing or other fabrics (such as tent walls [102] or mosquito nets [103]), not to skin. The spray form is nonstaining, nearly odorless, and resistant to degradation by heat or sun and maintains its potency for at least 2 weeks, even through several launderings (104, 105). The combination of permethrin-treated clothing and skin application of a DEET-based repellent creates a formidable barrier against mosquito bites (19, 106, 107). In a field trial conducted in Alaska, persons wearing permethrin-treated uniforms and a polymer-based 35% DEET product had more than 99.9% protection (1 bite/h) over 8 hours, even under conditions of intense biting pressures; unprotected persons received an average of 1188 bites/h (108).

Permethrin-based insecticide sprays available in the United States are listed in **Table 5**. To apply to clothing, spray each side of the fabric (outdoors) for 30 to 45 seconds, just enough to moisten it. Allow the garment to dry for 2 to 4 hours before wearing it.

Reducing Local Mosquito Populations

Consumers may still find advertisements for small ultrasonic electronic devices that are meant to be carried on the body and purportedly emit sounds that repel mosquitoes. Many studies conducted in the field and laboratory show that these devices do not work against mosquitoes (109–111). Encouraging natural predation of insects by setting up bird or bat houses in the backyard has also been unsuccessful in reducing local mosquito populations (112). Likewise, backyard bug "zappers," which lure and electrocute insects, are ineffective (113). Mosquitoes continue to be more attracted to humans than to the devices. One study conducted in homeowners' backyards showed that of the insects killed by these devices, only 0.13% were female mosquitoes (114). An estimated 71 billion to 350 billion beneficial insects may be killed annually in the United States by these electrocuting devices (114). The most effective way to reduce a local population of mosquitoes is to eliminate sources of standing water, such as old discarded tires, clogged gutters, planters, bird baths, or tree stump holes.

Relief from Mosquito Bites

Cutaneous responses to mosquito bites range from common localized wheal-and-flare reactions to delayed bite papules, rare systemic Arthus-type reactions, and anaphylaxis (115–117). Bite reactions are the result of sensitization to mosquito salivary antigens, which lead to the formation of specific IgE and IgG antibodies (118–121). Immediate-type reactions are mediated by IgE and histamine, whereas cell-mediated immunity is responsible for the delayed reactions.

Several strategies exist for relieving the itch of mosquito bites. Topical corticosteroids can reduce

the erythema, itching, and induration. Topical diphenhydramine and caine-containing derivatives should be avoided because of concerns about inducing allergic contact sensitivity. Oral antihistamines can be effective in reducing the symptoms of mosquito bites. Cetirizine was given prophylactically in a double-blind, placebo-controlled, 2-week, crossover trial to 18 persons who had previously had dramatic cutaneous reactions to mosquito bites (122). Persons who received the active drug had a statistically significant 40% decrease in the size of the wheal response at 15 minutes and the size of the bite papule at 24 hours. The mean pruritus score, measured 0.25, 1, 12, and 24 hours after the mosquito had bitten, was 67% less than that of the untreated controls. These studies have not been done with astemizole, terfenadine, loratadine, or fexofenadine. In highly sensitized persons, prophylactic treatment with nonsedating antihistamines may safely reduce the cutaneous reactions to mosquito bites.

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Attached is
Additional Information for
the Workshop Item

Workshop on the Leon County Mosquito Control Program and Adulticiding Alternatives

Workshop from 1:00 – 3:00 pm
Tuesday, February 9, 2010

This document distributed: February 9, 2010

"No Spray" Locations in Leon County, Florida

Leon County Public Works

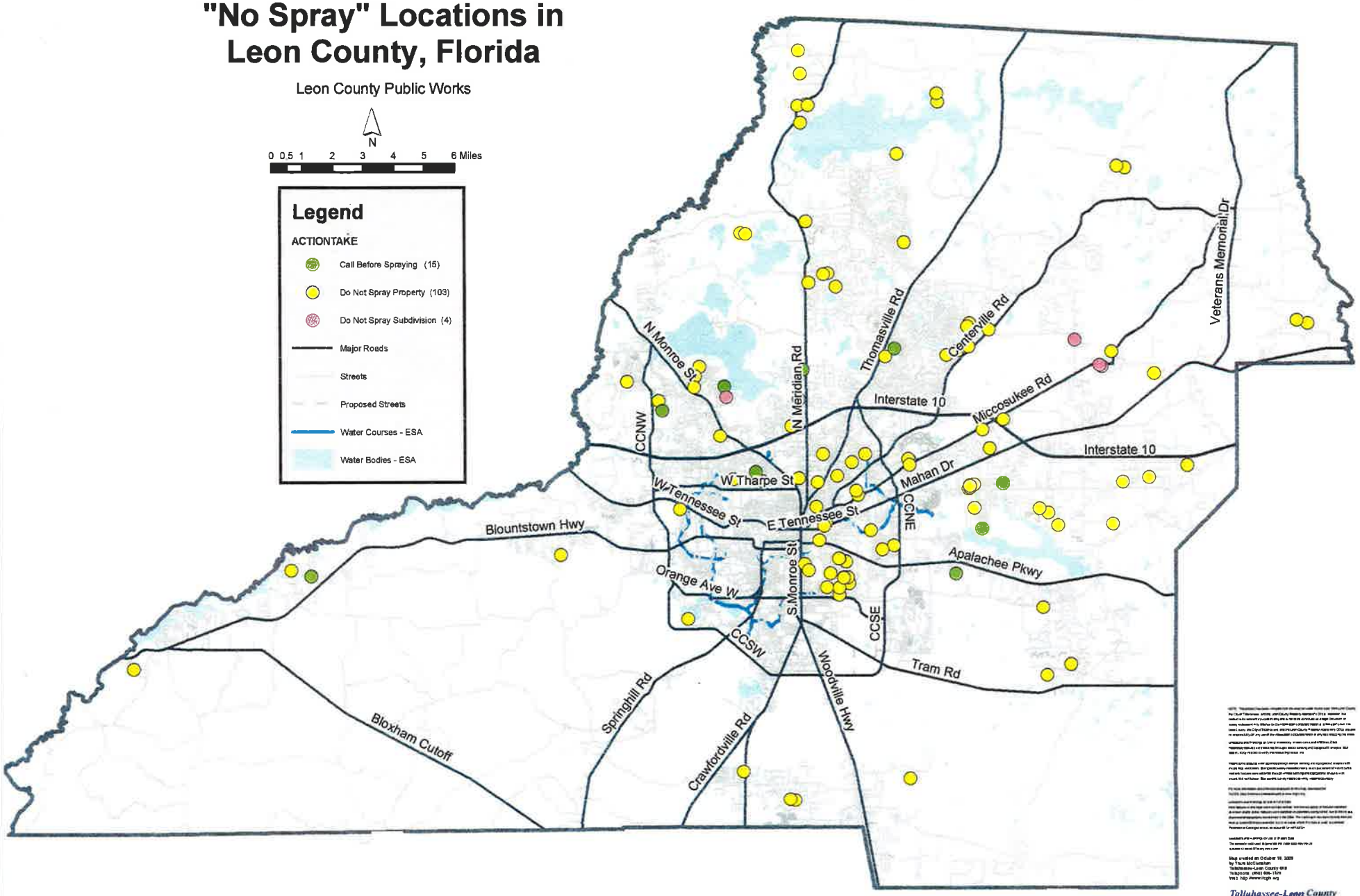
N

0 0.5 1 2 3 4 5 6 Miles

Legend

ACTIONTAKE

- Call Before Spraying (15)
- Do Not Spray Property (103)
- Do Not Spray Subdivision (4)
- Major Roads
- Streets
- Proposed Streets
- Water Courses - ESA
- Water Bodies - ESA



Map created on October 19, 2009
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